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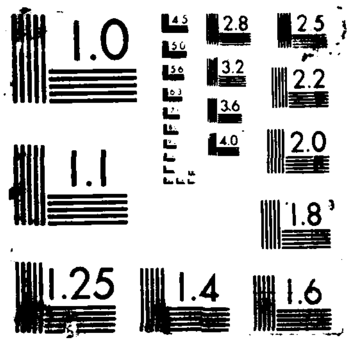
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AD-A195 525

INSTALLATION RESTORATION PROGRAM
PHASE II - CONFIRMATION/QUANTIFICATION
STAGE 1

BUCKLEY AIR NATIONAL GUARD BASE
COLORADO

DAMES & MOORE
1550 NORTHWEST HIGHWAY
PARK RIDGE, ILLINOIS 60068

MARCH 21, 1986

FINAL REPORT

APPROVED FOR PUBLIC RELEASE; DISTRIBUTION UNLIMITED

PREPARED FOR
HEADQUARTERS AIR NATIONAL GUARD
COMMAND SURGEON'S OFFICE (ANGSC/SGB)
BIOENVIRONMENTAL ENGINEERING DIVISION
ANDREWS AIR FORCE BASE, MARYLAND 20331-6008

UNITED STATES AIR FORCE
OCCUPATIONAL & ENVIRONMENTAL HEALTH LABORATORY (USAFOEHL)
TECHNICAL SERVICES DIVISION (TS)
BROOKS AIR FORCE BASE, TEXAS 78235-5501

INSTALLATION RESTORATION PROGRAM
PHASE II - CONFIRMATION/QUANTIFICATION
STAGE 1

FINAL REPORT

FOR

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COLORADO

HEADQUARTERS AIR NATIONAL GUARD
COMMAND SURGEON'S OFFICE (ANGSC/SGB)
BIOENVIRONMENTAL ENGINEERING DIVISION
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MARCH 21, 1986

PREPARED BY

DAMES & MOORE
1550 NORTHWEST HIGHWAY
PARK RIDGE, ILLINOIS 60068

USAF CONTRACT NO. F33615-83-D-4002, DELIVERY ORDER NO. 0024

APPROVED FOR PUBLIC RELEASE; DISTRIBUTION UNLIMITED

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The Buckley ANGB Phase II, Stage 1 field evaluation of the IRP investigated five sites through drilling and sampling nine borings and four monitor wells.

Bedrock and alluvial aquifers are of interest in the Buckley ANGB area, particularly since they both provide local and regional water supplies. The bedrock aquifers provide water for the base, but the shallower alluvial aquifers are used within a mile of the base boundaries. The alluvial aquifers, particularly the aquifer associated with East Toll Gate Creek, are vulnerable to contamination.

Ground water contamination has been found at Buckley ANGB. Cadmium levels exceeded the primary drinking water standards at the landfill and oil pit zone. TDS, TOX, TOC, and phenolics were also elevated at this site. At Site FT-3, the soil is contaminated, as evidenced by a strong fuel odor and elevated TOX and TOC.

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PREFACE

As part of the U.S. Air Force Installation Restoration Program (IRP), investigations were undertaken at five sites on Buckley Air National Guard Base, Colorado, to determine whether hazardous material contamination is present. This report, prepared by Dames & Moore under Contract No. F33615-83-D-4002, Order No. 0024, presents the results of the Phase II, Stage 1 IRP investigations. The period of field work reported on herein was October 1984 to December 1984. The project was directed by Dr. Kenneth J. Stimpfl. Dr. Richard Harlan provided technical management. Mr. Lawrence Cope, Staff Hydrogeologist, supervised the borehole drilling and monitor well installation with field assistance from Mr. Stephen Werner, Ground Water Technician. Dr. M. Carol McCartney, Project Hydrogeologist, and Ms. Carol J. Scholl, Staff Geologist, assisted in data interpretation and report preparation. Lt. Maria LaMagna, Technical Services Division, USAF Occupational and Environmental Health Laboratory (OEHL), was the Technical Manager.

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SUMMARY

Buckley Air National Guard Base (ANGB) is located in Arapahoe County, Colorado, in the city of Aurora. The base is on the western edge of the Great Plains physiographic province, which slopes gently eastward from the Rocky Mountain Front Range. Buckley ANGB has been in operation since 1942 and its current mission is to train Air National Guard personnel.

The Phase II field investigation of the Installation Restoration Program (IRP) consisted of investigations at the following sites:

- Site 1 - Landfill zone including oil pit;
- Sites FT-1, FT-2, and FT-3 - Fire training areas; and
- Site 5 - Storm drainage system near Bldg. 801.

The field investigation consisted of the following activities:

- Drilling, soil and water sampling, geologically logging and installing four monitor wells at Site 1; and

- Drilling, soil sampling, and geologically logging nine borings at the rest of the sites.

The ground water samples were analyzed for pH, temperature, specific conductance, cadmium, chromium, lead, nickel, silver, phenolics, total dissolved solids (TDS), total organic carbon (TOC), total organic halogens (TOX), and 14 pesticides (aldrin, p,p'-DDT, o,p-DDT, DDD, DDE, dieldrin, endrin, heptachlor, heptachlor epoxide, lindane, methoxychlor, 2,4-D, 2,4,5-TP (Silvex), and 2,4,5-T. The soil samples were analyzed for percent moisture, phenolics, TOC, and TOX at all sites and for lead at FT-1, FT-2, FT-3, and Site 5; at Site 1 they were also analyzed for the 14 pesticides.

Three major bedrock aquifers underlie Buckley ANGB, which is within the Denver Basin; they are, in ascending order, the Laramie-Fox Hills aquifer, the Arapahoe aquifer, and the Denver aquifer. Unconsolidated alluvial aquifers occur in present and ancestral stream valleys and terraces as saturated sand and gravel. The uppermost two bedrock aquifers and the alluvial aquifers are of concern at Buckley ANGB. Contaminated water in the surface Denver aquifer could flow downward to the Arapahoe aquifer, and the alluvial aquifers are local sources of water supply. The Denver Formation is 600 to 1000 feet of complexly interbedded sandstones, siltstones, claystones, and shale. The water-bearing layers are about 175 feet thick near Buckley ANGB. The Arapahoe Formation is 400 to 700 feet of conglomerate, sandstone, siltstone, and shale; near Buckley, the water-bearing layers are about

150 feet thick. The alluvial aquifers, which are generally coarse grained, are vulnerable to contamination because pollutant attenuation is expected to be minimal, and downgradient movement would be rapid.

Contamination of the ground water has been found at Buckley ANGB. Cadmium levels exceeded primary drinking water standards at the landfill zone and oil pit. This is an area where it is likely the bedrock aquifer discharges to the alluvial aquifer associated with East Toll Gate Creek, and water quality in the alluvial aquifer may be affected. The soil at Buckley is contaminated at Site FT-3, as evidenced by a strong fuel odor and elevated TOX and TOC. This site is also in an area where contaminated ground water would probably discharge to the East Toll Gate Creek aquifer. Downgradient users of this aquifer are within 1 mile of the base boundaries.

Ground water sampling and analysis at Sites FT-1, FT-2, and FT-3 are recommended to assess whether these sites had an impact on water quality.

The following summarizes our recommendations and rationale for further investigations:

Site	Recommended Action	Rationale
CATEGORY 2 - SITES REQUIRING FURTHER INVESTIGATIONS		
1	Install four new monitor wells, one upgradient and three downgradient, along East Toll Gate Creek drainage. Sample these wells and existing monitor wells for TDS, pH, specific conductance, temperature, purgeable halocarbons (USEPA Method 601), purgeable aromatics (USEPA Method 602), lead (Method of Standard Additions, EPA-600/4-79-020, Revised March 1983, Metals, Atomic Absorption Methods, ¶8.5), phenolics, and cadmium.	To verify the presence of contaminants determined during the Phase II, Stage 1 investigation, and to determine the cause of the TOX concentrations.
	Conduct resistivity survey of the area along East Toll Gate Creek downgradient of the landfill (off base) and the area between the oil pit and the creek.	To define the extent of the contaminant plume downgradient of the landfill and oil pit.

Site	Recommended Action	Rationale
FT-3	Install two downgradient and one upgradient well and sample for purgeable aromatics (USEPA Method 602), purgeable halocarbons (USEPA Method 601), TDS, phenolics, pH, temperature, specific conductance, and lead (Method of Standard Additions, EPA-600/4-79-020, Revised March 1983, Metals, Atomic Absorption Methods, ¶8.5).	To determine whether the ground water, as well as the soil, is contaminated at this site.
FT-1, FT-2, and 5	Install one downgradient well at each of these sites and analyze for the parameters listed for FT-3.	To determine whether ground water contamination has resulted from these sites.
Base Wells	Resample and analyze the four base wells for purgeable halocarbons (USEPA Method 601), purgeable aromatics (USEPA Method 602), and chlorides.	To determine the cause of the TOX concentrations in these wells.
	CATEGORY 3 - SITES REQUIRING REMEDIAL ACTIONS	
Oil Pit	Develop a remedial action plan and initiate closure proceedings.	To halt this ongoing source of soil and ground water contamination.

I. INTRODUCTION

A. BACKGROUND

The Department of Defense (DOD) initiated the Installation Restoration Program (IRP) to investigate and mitigate any environmental contamination that may be present at DOD facilities as a result of handling or disposing of hazardous materials. The IRP was issued as Defense Environmental Quality Program Policy Memorandum (DEQPPM) 81-5 in 1981. The U.S. Air Force (USAF) implemented DEQPPM 81-5 in 1982 as a four-phased program:

Phase I Program Identification/Records Search
Phase II Program Confirmation and Quantification
- Several stages as necessary
Phase III Technology Base Development
Phase IV Corrective Action

For Buckley Air National Guard Base (ANGB), Aurora, Colorado, Phase I was completed by Simons, Li & Associates, Inc. (1982). Dames & Moore has been retained by the USAF under Contract F33615-83-D-4002, Order 0024, to conduct the Phase II, Stage 1 field evaluation. The location of Buckley ANGB is provided on the Location Map (Plate 1).

This report presents the results of Dames & Moore's Phase II, Stage 1 field and laboratory investigations in the vicinity of hazardous waste disposal and handling areas at Buckley ANGB. Chemical analyses were performed by UBTL, Inc., of Salt Lake City, Utah, as a subcontractor to Dames & Moore.

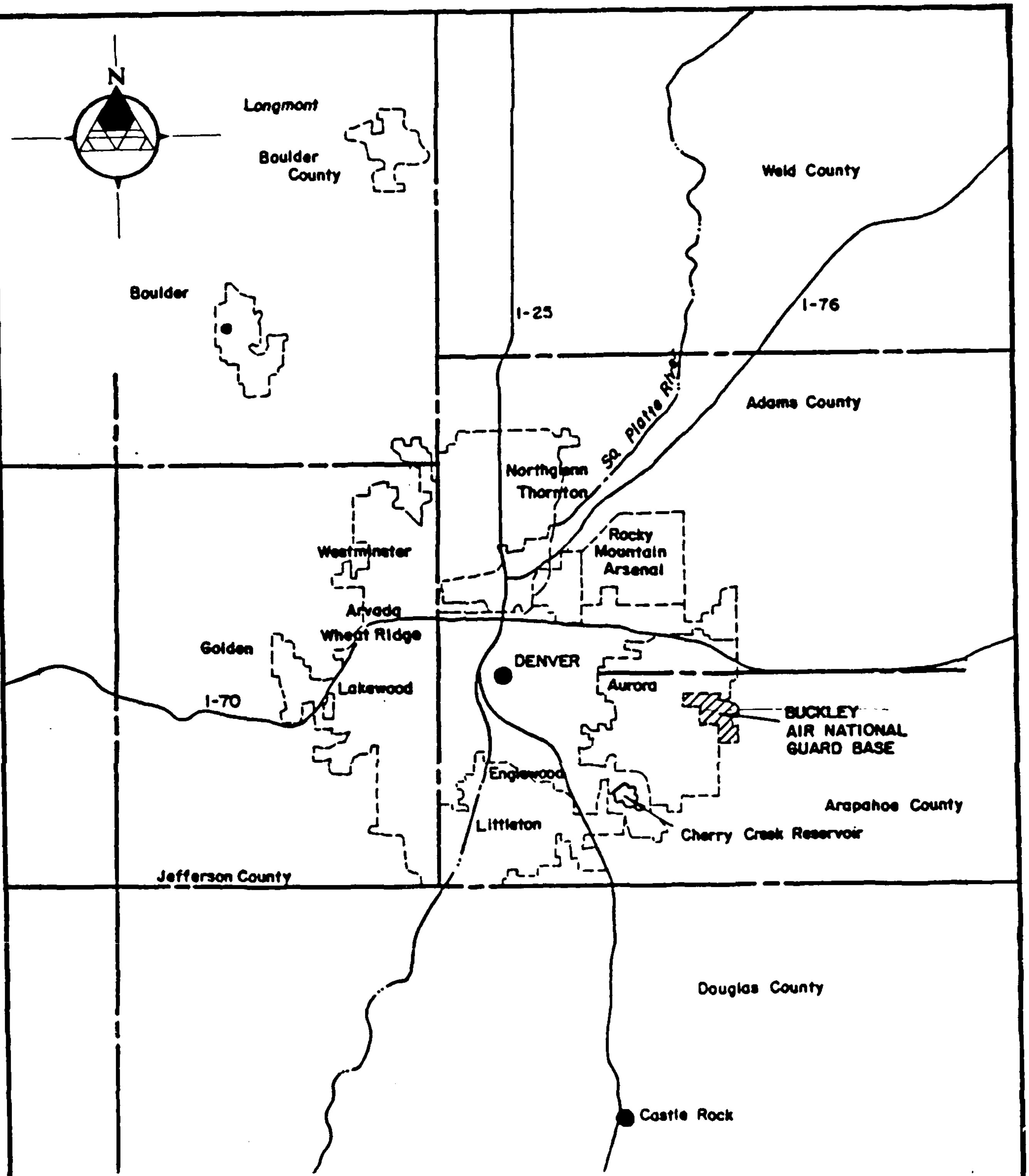
B. PURPOSE AND SCOPE

The purposes of the field evaluation portion of Phase II, Stage 1 of the IRP were to:

1. Determine whether environmental contamination has resulted from material handling or waste disposal practices at Buckley ANGB;

2. Provide estimates of the magnitude and extent of contamination, if contamination was found; and

3. Identify and recommend any additional investigations and their attendant costs necessary to identify the magnitude, extent, and direction of movement of discovered contaminants.



LOCATION MAP
BUCKLEY ANGB

SOURCE: SIMM, LI AND ASSOCIATES, INC., 1982

Dames & Moore

PLATE I

The scope of work as outlined for Phase II, Stage 1 of the IRP consisted of the following activities:

1. Drilling, soil sampling, and geologically logging nine borings to a depth of 11 feet at four locations;

2. Drilling, soil sampling, geologically logging, and installing four monitor wells to depths ranging from 33 to 68 feet at one location;

3. Analyzing selected soil samples from each boring for total organic carbon (TOC), total organic halogens (TOX), and phenolics, and from some borings for pesticides and lead;

4. Analyzing selected ground water samples for TOC, TOX, phenolics, total dissolved solids (TDS), trace metals, pesticides, pH, temperature, and specific conductance; and

5. Preparing this report, which presents our findings and recommendations.

Field work began in October 1984 and continued through December 1984. Base wells were sampled on 20 March 84 during the Presurvey Site Tour by Dr. Kenneth J. Stimpfl, Project Leader, and the results were presented in the Presurvey Report (Dames & Moore, 1984).

C. HISTORY OF BUCKLEY ANGB AND WASTE DISPOSAL OPERATIONS

Buckley ANGB, comprising 3540 acres, is located in the city of Aurora, Arapahoe County, Colorado. The base was activated in 1942 with an initial mission to train bombardiers and armorers for the U.S. Army Air Corps for the war effort. Subsequently, the base has operated under Army, Navy, and Air National Guard command. Currently, the primary mission of the base is to train Colorado Air National Guard personnel to combat readiness. Buckley is the only military flying base in the area and supports 60 base assigned aircraft and up to 10,000 transient military aircraft per year.

Hazardous wastes and materials have been used and generated at Buckley ANGB since 1942 in aircraft and ground vehicle maintenance, fuel storage and dispensing, operation of utility systems, general base maintenance activities, and fire training. Maintenance operations generate waste solvents, contaminated fuels and hydraulic fluids, degreasers, dye penetrants, and other associated materials. Before 1981, these fluids were stored in an underground fuel tank near Building 815 and were burned in fire training exercises or at the base dump. Used oil was dumped into the oil pit near the Civil Engineering Shops. Currently, these wastes are disposed of

through the Defense Property Disposal Office (DPDO) in Fort Carson. Fuels used and stored at Buckley ANGB include JP-4 jet fuel, No. 2 diesel fuel, AVGAS 130, and MOGAS. No spills greater than 100 gallons have been reported, but use of an old aquasystem fuel storage tank near Building 800 was discontinued due to leakage problems. From the 1940s through the 1960s, fuel tank sludges and filters were deposited at the base dump. Today, contaminated fuels are used in fire training and hazardous wastes are turned in to Defense Property Disposal Office through base supply channels. General base maintenance activities have included pest control, including DDT use from 1942 until the late 1950s, and road oiling for dust control. Empty pesticide containers were disposed of in the base dump.

D. DESCRIPTION OF SITES

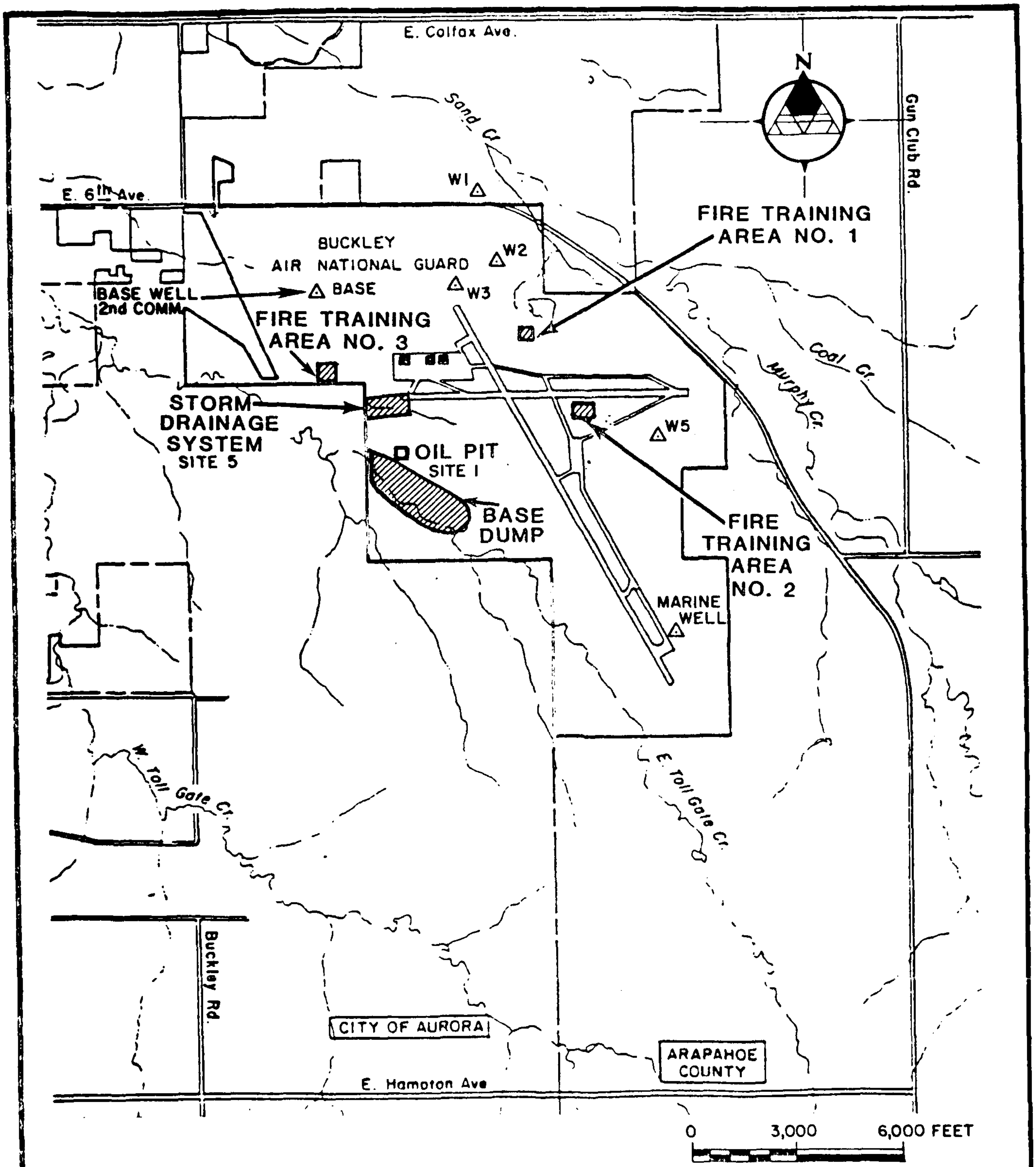
Simons, Li & Associates (1982) identified eight sites with low to moderate potential for environmental contamination at Buckley ANGB. These sites were:

- Fire Training Area No. 2;
- Oil pit;
- Base dump;
- Fire Training Area No. 3;
- Fire Training Area No. 1;
- Storm drainage system;
- Sludge drying beds; and
- Army aircraft burial site.

Of these eight sites, the following five sites were considered to have the greatest potential for environmental impacts and were investigated during Phase II, Stage 1:

- Landfill zone including oil pit (Site 1);
- Fire protection training areas (Sites FT-1, FT-2, and FT-3); and
- Storm drainage system near Building 801 (Site 5).

The sites investigated during Phase II, Stage 1 are shown on Plate 2, and each site is described below.



KEY:

W1 △ BASE WELLS

▨ SITES INVESTIGATED DURING THIS STUDY

SITES INVESTIGATED
DURING PHASE II, STAGE 1, IRP
BUCKLEY ANGB

DRAWING REFERENCE:
TITLED: RECOMMENDED MONITORING LOCATIONS AND BASE WATER WELLS
FOR: BUCKLEY AIR NATIONAL GUARD BASE
BY: SIMONS, LI & ASSOCIATES, INC.
DATE: 1982

Dames & Moore

PLATE 2

1. Site 1 - Landfill Zone Including Oil Pit

The base landfill is located near the west installation boundary and extends eastward along the floodplain of East Toll Gate Creek for approximately 3000 feet (Plate 2). The landfill was in operation from 1942 to 1982 and received municipal refuse from Buckley ANGB from 1942 until 1968 and from Lowry Air Force Base during the early 1960s. Building materials, paint cans, pesticide containers, fuel tank sludges, and construction rubble are known to have been disposed of in the landfill. During the period of Navy occupation (1947 to 1959), and perhaps for several years thereafter, the landfill was burned periodically. It is assumed that waste oil and other flammable materials may have been used to aid burning. Trench and fill methods were also utilized at this site.

The landfill lies within the floodplain of East Toll Gate Creek and, on at least one occasion in 1965, has been under water. The floodplain soils, although relatively impermeable, are subject to erosion and degradation. The water table is reported to be variable but is generally about 5 feet below the creek bed (Simons, Li & Associates, 1982).

The City of Aurora has requested that a right-of-way easement for a sewer line be granted. The line will parallel East Toll Gate Creek just south of the landfill.

The oil pit, in use between 1950 and 1982, is located adjacent to the base landfill southeast of Building 711. Approximately 10 feet square, the pit is enclosed by concrete walls, and it is not known if the bottom is lined. The pit was burned on occasion during the 1950s. Materials disposed of in the pit other than oil are unknown.

Because of the types of materials disposed of and the location of the base landfill and oil pit within the floodplain of East Toll Gate Creek, a potential for migration of contaminants exists at this site.

2. Sites FT-1, FT-2, and FT-3 - Fire Protection Training Areas

Three sites have been used for fire protection training activities at Buckley ANGB since the 1940s. Site FT-2, located near the control tower area, was in use between 1950 and 1972 and received the highest Hazard Assessment Rating Methodology (HARM) score (63) among the fire training areas. At this site, hazardous materials including AVGAS and JP-4 and possibly waste solvents were burned. The site is unlined and undiked, as are the other two fire training areas. FT-2 is within 2000 feet of base well No. 5, a potable water supply well.

FT-3, located west of Building 801, has been in operation since 1972. As described in the Phase I report, fire training exercise procedures involve adding water to the area to reduce infiltration, and then approximately 150 gallons of water-contaminated JP-4 fuel is ignited. Fires are extinguished with water and 6 percent aqueous film-forming foam (AFFF). Twenty-four exercises are conducted annually, during which time 400 gallons of AFFF are used. During the exercise, fire department personnel estimate that approximately 50 to 70 percent of the fuel is burned. Similar procedures were used at FT-2, except that a protein-based foam was employed. Exercises occurred approximately six times a month.

During the late 1940s and early 1950s, Site FT-1, located southwest of the abandoned reservoir, was used as an AVGAS burning site. The frequency of the exercises is unknown.

Because all three fire training areas are unlined and undiked and residual flammable materials were permitted to remain on site, these areas have a potential for contaminant accumulation and migration.

3. Site 5 - Storm Drainage System Near Building 801

At Buckley ANGB, stormwater is collected in a system of pipes, culverts, and open ditches. East of the north-south runway, drainage is discharged to Sand Creek. West of this runway, drainage flows to East Toll Gate Creek. Spills are generally washed to the nearest stormwater collector.

The practice of washing and painting aircraft on the apron south of Building 801 occurred between 1942 and 1982. The apron was washed with water, which either infiltrated at this location or flowed off to the south, entered a drainage ditch, and flowed off the base. Fuels, cleaning compounds, ethylene glycol, paints, and strippers are materials known to have been washed off the apron in this locality. These materials may migrate through sediments leaching into the local surface waters and possibly infiltrate into and contaminate the ground water system.

E. IDENTIFICATION OF POLLUTANTS SAMPLED

Based on the wastes present in the above sites, potential contaminants include organic carbons, organic halogens, phenolics, pesticides, and the heavy metals nickel, lead, cadmium, chromium, and silver. For this effort, the analysis scheme is provided in Table 1. Ground water samples were measured in the field for temperature, pH, and specific conductance. Laboratory analyses were provided by UBTL, Inc., Salt Lake City, Utah, as a subcontractor to Dames & Moore.

TABLE 1

CHEMICAL ANALYSIS SCHEME
BUCKLEY ANGB, COLORADO, PHASE II, STAGE 1

SITE	TOC, TOX	PHENOLICS	TDS	PESTICIDES	TRACE METALS
Site 1	4W 12S	4W 12S	4W	4W[a] 12S[a]	4W[b]
Site FTA-2	4S	4S	--	--	4S[c]
Site FTA-3	4S	4S	--	--	4S[c]
Site FTA-1	4S	4S	--	--	4S[c]
Site 5	6S	6S	--	--	6S[c]

Note: W = water samples, S = soil samples.

[a]Aldrin, DDT isomers, dieldrin, endrin, heptachlor, heptachlor epoxide, methoxychlor, 2,4-D, 2,4,5-T, and Silvex.

[b]Nickel, lead, cadmium, chromium, and silver.

[c]Lead only, nitric acid extract of soil.

F. IDENTIFICATION OF THE FIELD TEAM

The field investigations required for Phase II, Stage 1, were accomplished under the direction of Dr. Kenneth J. Stimpfl. Mr. Larry Cope, Staff Hydrogeologist, supervised the borehole drilling and monitor well installation with field assistance from Mr. Steve Werner, Ground Water Technician. Additional assistance in data compilation and analysis and report preparation was provided by Dr. M. Carol McCartney, Project Hydrogeologist, and Ms. Carol J. Scholl, Staff Geologist. Drilling services were provided by Custom Auger Drilling Services, Inc., Denver, Colorado, as a subcontractor to Dames & Moore. Appendix I contains biographies of key personnel.

II. ENVIRONMENTAL SETTING

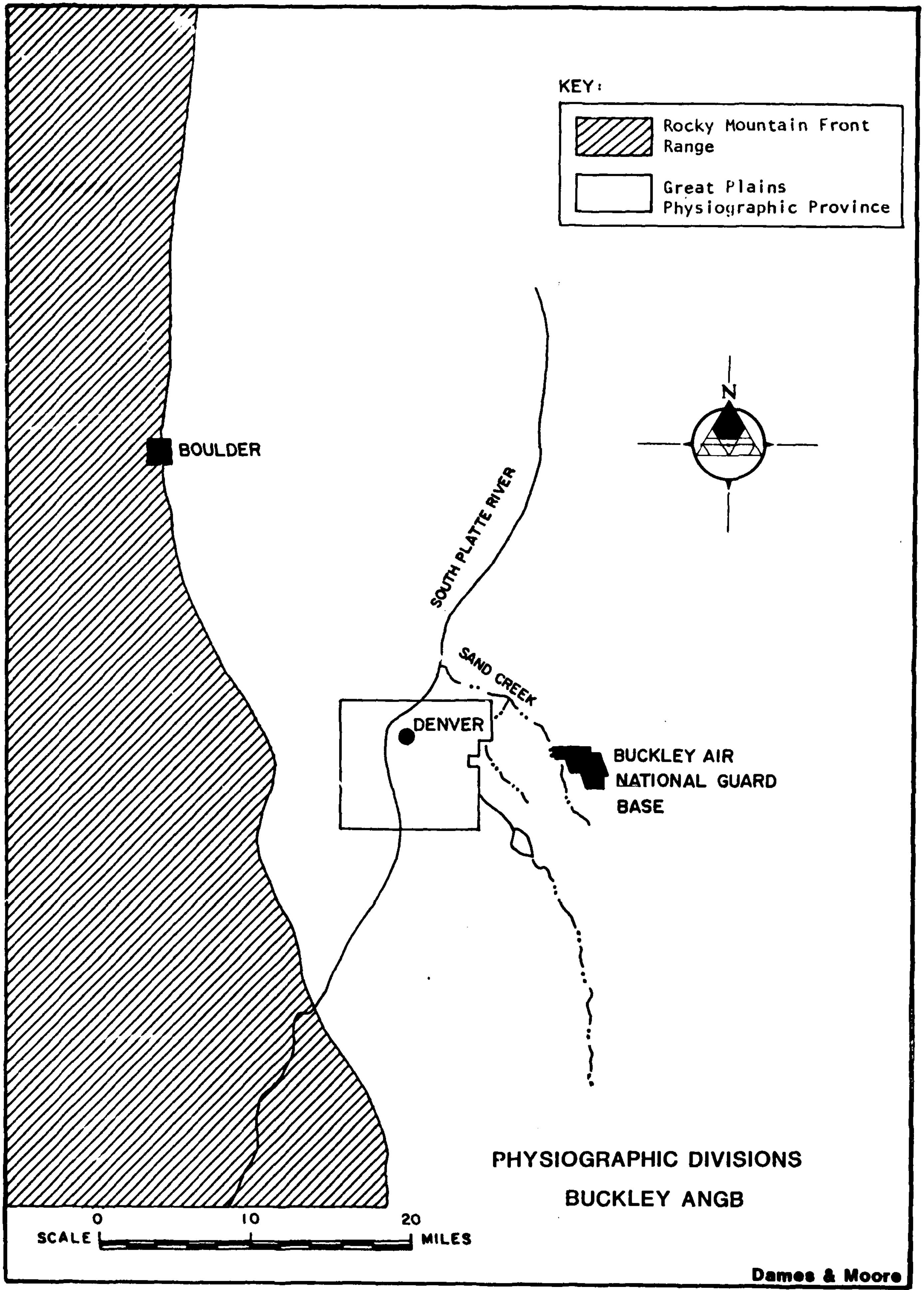
A. PHYSICAL GEOGRAPHY

Buckley ANGB occupies 3540 acres in the city of Aurora, Colorado. Land usage adjacent to the base is industrial and agricultural to the north, commercial and residential to the west, residential and agricultural to the south, and agricultural to the east.

The base is located along the western edge of the Great Plains physiographic province (Plate 3), which slopes eastward from the Rocky Mountain Front Range. This portion of the Great Plains province is characterized by rolling hills and relatively steep drainageways. The ground slope at Buckley ANGB is 1 percent to the northwest from an elevation of 5700 feet above mean sea level (msl) at the southeast corner to 5480 feet msl at the northwest corner (Plate 4).

The main runway at Buckley ANGB approximately coincides with the drainage divide between Toll Gate Creek Basin and Sand Creek Basin (Plate 4). Drainage from the base is ultimately to the South Platte River, to the northeast, via these creeks. The intermittent East Toll Gate Creek crosses the southwest corner of the site. The main channel of Sand Creek, which sustains a small base flow throughout most of the year, lies just northeast of the base. Surface drainage at the base is accomplished by overland flow to drainage channels leading to either of these creeks. Generalized surface flow is to the northeast on the east side of the drainage divide and to the west on the west side of the drainage divide.

The normal annual precipitation in the area is 15.5 inches. The climate is semiarid, and yearly net precipitation is approximately -30 inches. The potential for contaminant migration in the area is reduced by this low net precipitation. Average monthly temperatures range from 29.9°F in January to 73°F in July (Simons, Li & Associates, 1982).


KEY:
Rocky Mountain Front Range
Great Plains Physiographic Province
N
BOULDER
SOUTH PLATTE RIVER
SAND CREEK
DENVER
BUCKLEY AIR NATIONAL GUARD BASE
PHYSIOGRAPHIC DIVISIONS
BUCKLEY ANGB
0
10
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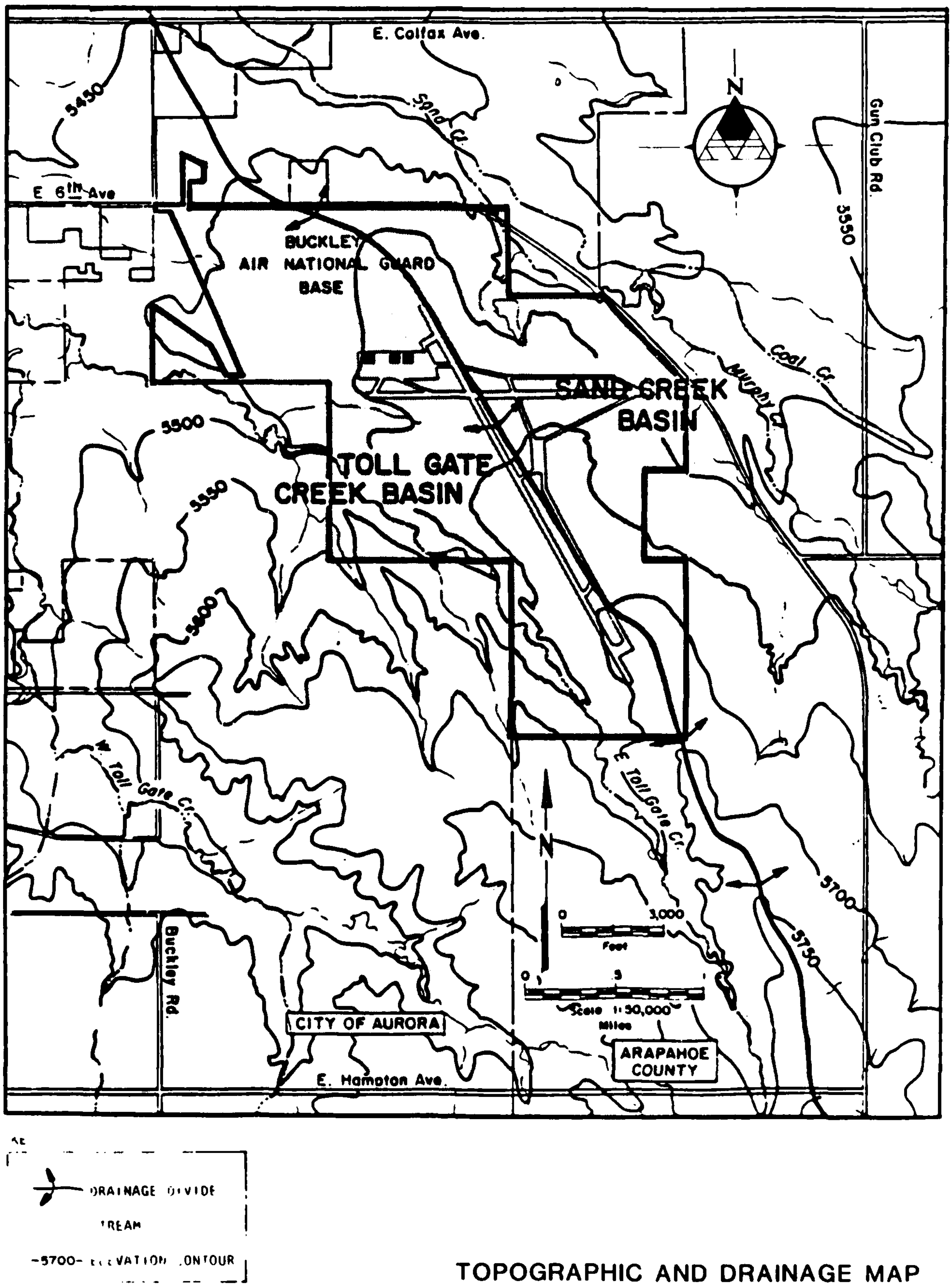
SCALE
MILES
Dames & Moore

PLATE 3



TOPOGRAPHIC AND DRAINAGE MAP
BUCKLEY ANGB

Dames & Moore

PLATE 4

B. REGIONAL GEOLOGY AND HYDROGEOLOGY

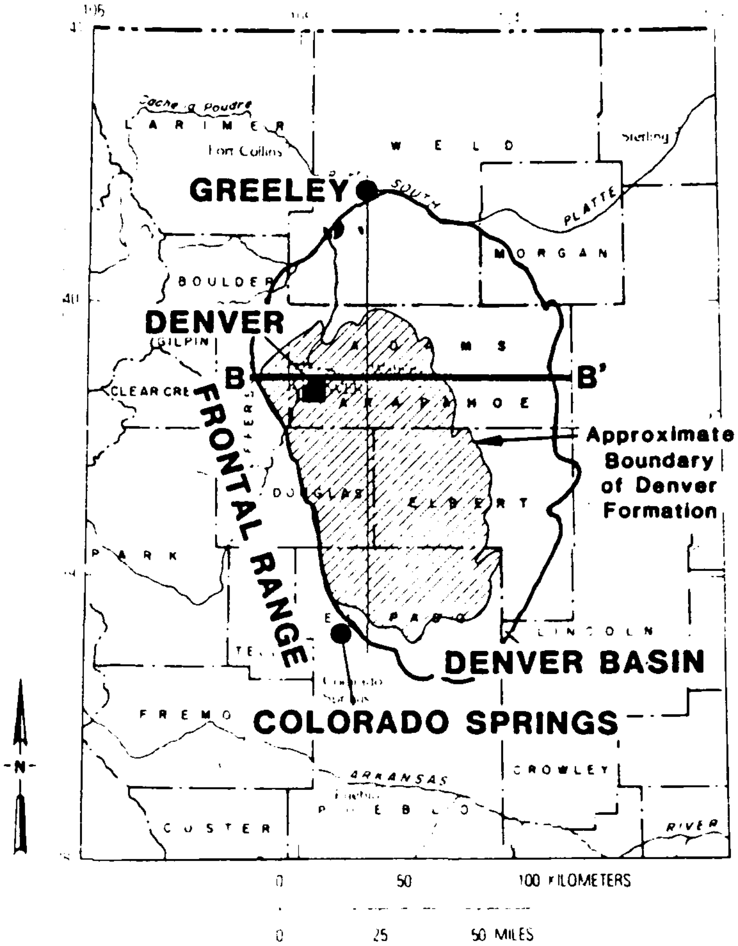
Buckley ANGB is located within the Denver Basin (Plate 5), which is comprised primarily of interbedded shales, claystones, siltstones, and sandstones ranging from Late Cretaceous to Early Tertiary in age. Also present are interspersed zones of conglomerates, limestone, lignite, coal, tuff, and lava. The Pierre Shale is considered to be the base of the bedrock-aquifer system in the Denver Basin due to its low permeability and great thickness (up to 8000 feet). In ascending order, the formations overlying the Pierre Shale include the Late Cretaceous Fox Hills Sandstone, approximately 200 feet of shale, shaley sandstone and sandstone; and the Laramie, 600 to 650 feet of sand, clay, and shale with many coal seams. Next in the sequence are the Late Cretaceous age Arapahoe Formation, the Denver Formation, and the Tertiary age Dawson Arkose. These formations include 1000 to 1200 feet of sand, clay, shale, and sandstone with some coal seams. Surficial deposits in the basin are Quaternary age loess and alluvium of varying thickness.

The Denver Basin is seismically active, and the area near Buckley ANGB has been the center of earthquakes ranging from II to VII on the Modified Mercalli Intensity Scale since 1962.

The four major bedrock aquifers that occur in the Denver Basin are, in ascending order, the Laramie-Fox Hills aquifer, the Arapahoe aquifer, the Denver aquifer, and the Dawson aquifer. Alluvial aquifers are common along drainageways. The Dawson aquifer occurs only in the south-central section of the basin.

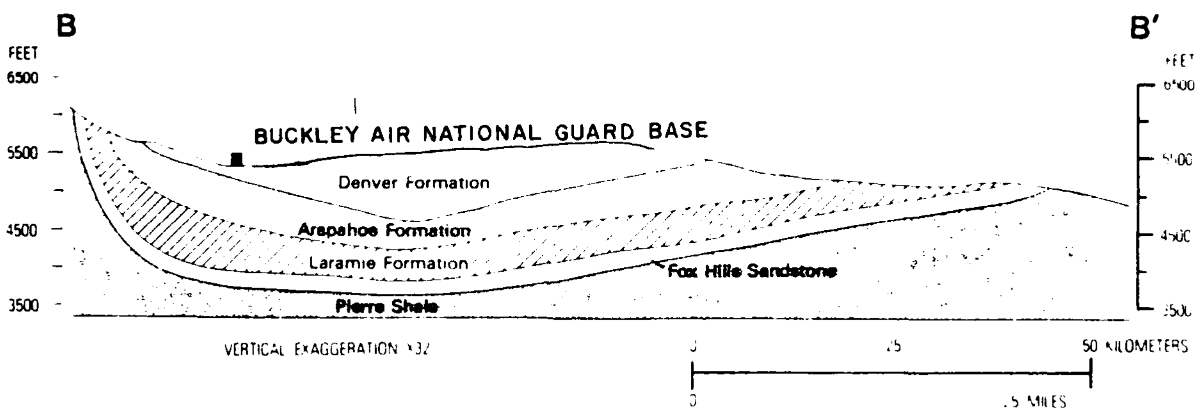
The aquifers in the Denver Basin below the Dawson are recharged by leaking from the overlying aquifers or by precipitation and streams in the areas of outcrop along the aquifer margins. In general, water table conditions exist in these aquifers in their outcrop areas, and artesian conditions exist elsewhere. Ground water quality is generally good in these aquifers in the area but they all have areas of higher iron, sulfate, or hardness. Flow in the Denver aquifer is generally from the central area out to the margins; in the lower Arapahoe and Laramie-Fox Hills aquifers, flow is generally from the south to the north in the northern two-thirds of the basin. In all three aquifers, flow lines are complicated by the trough along the South Platte River in the northwest corner of the basin. This natural trough filled with Quaternary alluvial deposits has been increased by ground water pumping from the bedrock and alluvial aquifers in this area. Alluvial aquifers occur as saturated sand and gravel and ancestral stream valleys and terraces. These aquifers, as well as the three bedrock aquifers, provide water for urban, suburban, and rural uses.

A LOCATION OF DENVER BASIN



SOURCE: ENGINEERING-SCIENCE, 1983

B GEOLOGIC CROSS-SECTION THROUGH DENVER BASIN



RELATION BETWEEN GEOLOGIC STRUCTURE AND STRATIGRAPHY
BUCKLEY ANGB

DRAWING REFERENCE: ROBSON AND OTHERS, 1981

Dames & Moore

C. GENERAL BASE HYDROGEOLOGY

The surface geology at Buckley ANGB is comprised of Quaternary alluvial sands, clays, silts, and gravels along stream beds and terraces above stream beds; loess and eolian sands forming extensive sand hills throughout much of the center of the base; and outcrops of Late Cretaceous to Early Tertiary age Denver Formation.

In descending order, the principal aquifers underlying the base are the Denver Formation and the Arapahoe Formation. The Denver Formation is a 600- to 1000-foot thick series of irregularly bedded, permeable sandstones and siltstones complexly interbedded with relatively impermeable claystone and shale. The total thickness of water-bearing layers in the Denver Formation is about 175 feet in the Buckley ANGB area.

The Late Cretaceous age Arapahoe Formation is a 400- to 700-foot thick sequence of interbedded conglomerate, sandstone, siltstone, and shale. Hydrologically, the upper 50 to 100 feet of the underlying Late Cretaceous age Laramie Formation is generally considered to function as part of the Arapahoe Aquifer. The thickness of water-bearing layers is about 150 feet in the Arapahoe Aquifer at Buckley. The Denver and Arapahoe aquifers are similar in terms of complexity and variability.

Within the Denver and Arapahoe aquifers, ground water flow at the base is generally in the north-northwesterly direction, towards troughs along the South Platte River. The potentiometric elevation of the Denver aquifer was 150 to 200 feet below the land surface in 1978; at that time, the potentiometric surface of the Arapahoe aquifer was about 100 feet lower. Therefore, water will tend to flow downward from the Denver aquifer into the Arapahoe aquifer. The upper portion of the Denver aquifer near Buckley ANGB is partially saturated; during periods of high ground water, springs issue near the runways at the base.

There are approximately 40 wells, for both domestic and livestock use, immediately north and northwest of Buckley ANGB. The presence of hazardous substances at the surface or subsurface would create a potential for contamination of the water supply in this area. Also, because the Denver aquifer water table is higher than the Arapahoe aquifer, contaminated water can flow downward to the Arapahoe aquifer.

D. SITE-SPECIFIC GEOLOGY AND HYDROGEOLOGY

This section presents the results of the surface and subsurface investigations conducted during Phase II, Stage 1 at the five previously listed sites at Buckley ANGB. The field program is described in Section III, and the results of the chemical analyses are presented in Section IV. Logs of borings are presented in Appendix C.

1. Site 1

Site 1 was operated as the base landfill from 1942 to 1982. Four monitor wells (MW-1, MW-2, MW-3, and MW-4) were completed to depths of approximately 68 feet at MW-1 and MW-2 and about 35 feet at MW-3 and MW-4 (see Plate 6). MW-1 and MW-2 are located south and upgradient of the landfill; MW-3 and MW-4 are in an area believed to be downgradient of the landfill and oil pit. Table 2 lists the monitor well construction data.

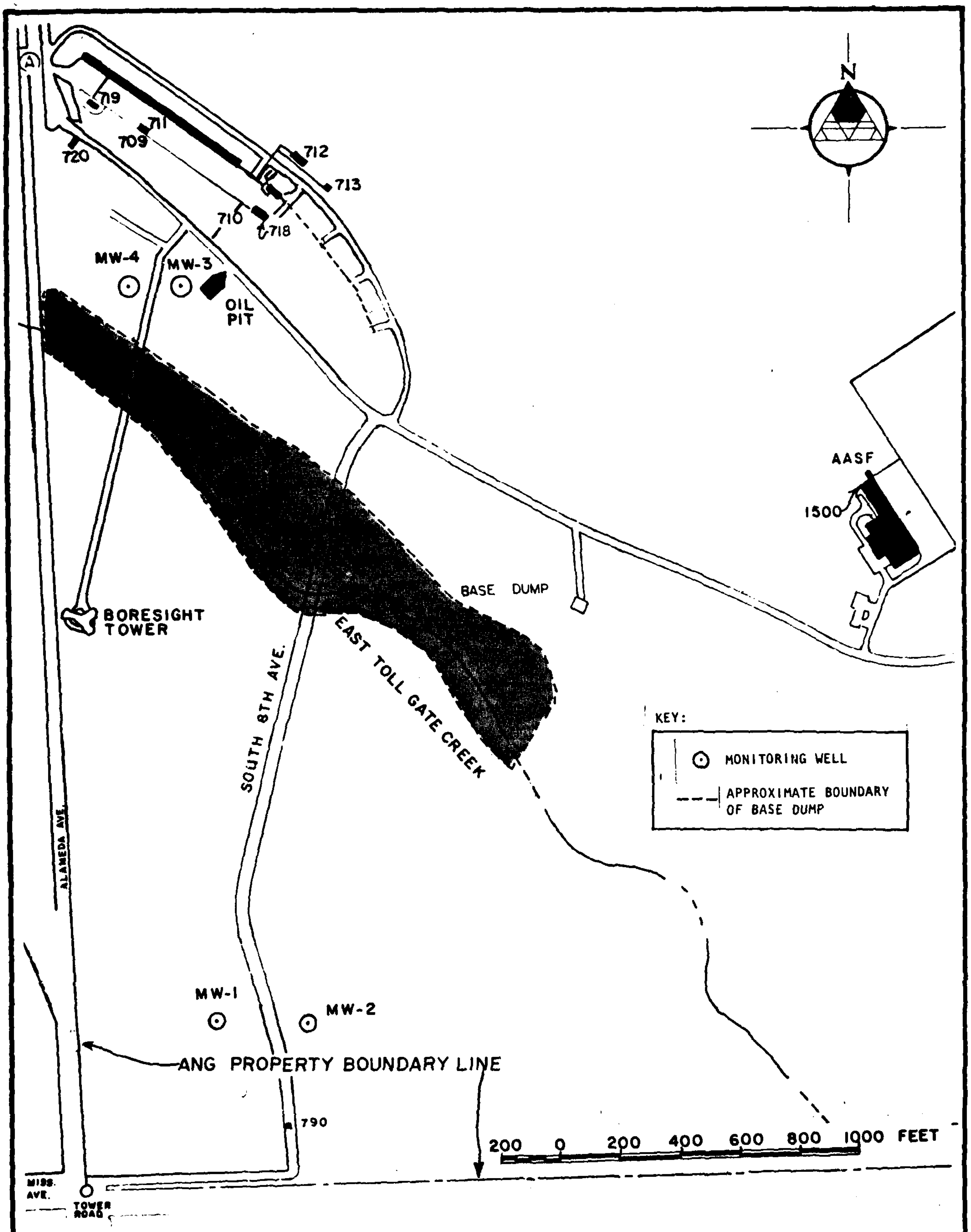
The subsurface profile at MW-1 and MW-2 consists of blue to blue-gray shale or siltstone interbedded with yellow to brown sandy clay and sandstone (see Appendix C). Water was encountered while drilling MW-1 and MW-2 on 23 October 84 and 26 October 84, respectively. After development, MW-2 remained dry and was, therefore, not included in water quality analyses. MW-1 contained a small amount of water after development and does not penetrate the true water table. It is believed that both MW-1 and MW-2 drained a perched lens of water.

The subsurface profile at MW-3 and MW-4 (see Appendix C) consists of interbedded clay, silty sand, and some sand and gravel. MW-4 reached the blue shale found in MW-1 and MW-2. Water was encountered in MW-3 at about 15 feet on 24 October 84 and at about 12 feet on 25 October 84 in MW-4. Both borings encountered a spongy, black, organic silt at about 15 feet.

Percent moisture in analyzed soil samples ranged from 10 percent in MW-1 and MW-2 to 21 percent in MW-4. HNU photoionization meter readings were at background levels during drilling of these borings.

2. Sites FT-1, FT-2, and FT-3

Fire protection training activities have been undertaken at Buckley ANGB since the 1940s at these three sites. Two soil borings were drilled, sampled, and logged at each site.



SITE 1 - LANDFILL & OIL PIT ZONE
BUCKLEY ANGB

SOURCE: BUCKLEY ANGB DEVELOPMENT PLAN MAP, 1984

Dames & Moore

PLATE 6

TABLE 2

MONITOR WELL CONSTRUCTION DETAILS

WELL	DEPTH[a]	SCREENED INTERVAL[a] FROM	TO	TOP OF GRAVEL PACK[a]	GROUND SURFACE ELEVATION[b]	TOP OF PIPE ELEVATION[b]	WATER TABLE ELEVATION[b]
MW-1	68.0	58.0	68.0	10.0	5547.08	5549.85	5523.48
MW-2	68.0	48.0	68.0	18.0	5558.14	5560.58	dry
MW-3	40.0	10.0	40.0	9.0	5517.94	5520.59	5503.84
MW-4	33.0	8.0	33.0	8.0	5515.37	5517.80	5503.07

[a]*Feet below ground surface.*

[b]Feet above mean sea level.

Subsurface materials at FT-2 (Plate 7) consisted of a light brown sandy clay over a gray claystone (see Appendix C). The borings, to 11.5 feet, did not encounter the water table. Analyzed soil samples ranged from 15 to 19 percent moisture. HNU photoionization meter readings were at background levels during drilling.

At FT-3 (Plate 8), the subsurface materials consisted of a surface gravel fill over silt or siltstone interbedded with sand and some gravel (see Appendix C). A strong fuel odor was noted in B-1, which was wet at the surface; the fuel odor was light in B-2, which was dry. Analyzed soil samples had 11 percent moisture in B-1 and 4 to 9 percent moisture in B-2. Both borings ended at 11.5 feet. HNU photoionization meter readings were at background levels during drilling.

Subsurface materials at FT-1 (Plate 9) consisted of white and brown weathered claystone with silty sand at B-2 over a red sandy siltstone or claystone (see Appendix C). The borings, which ended at 11.5 feet, did not encounter water. Moisture in analyzed soil samples ranged from 6 to 13 percent. HNU photoionization meter readings were at background levels during drilling.

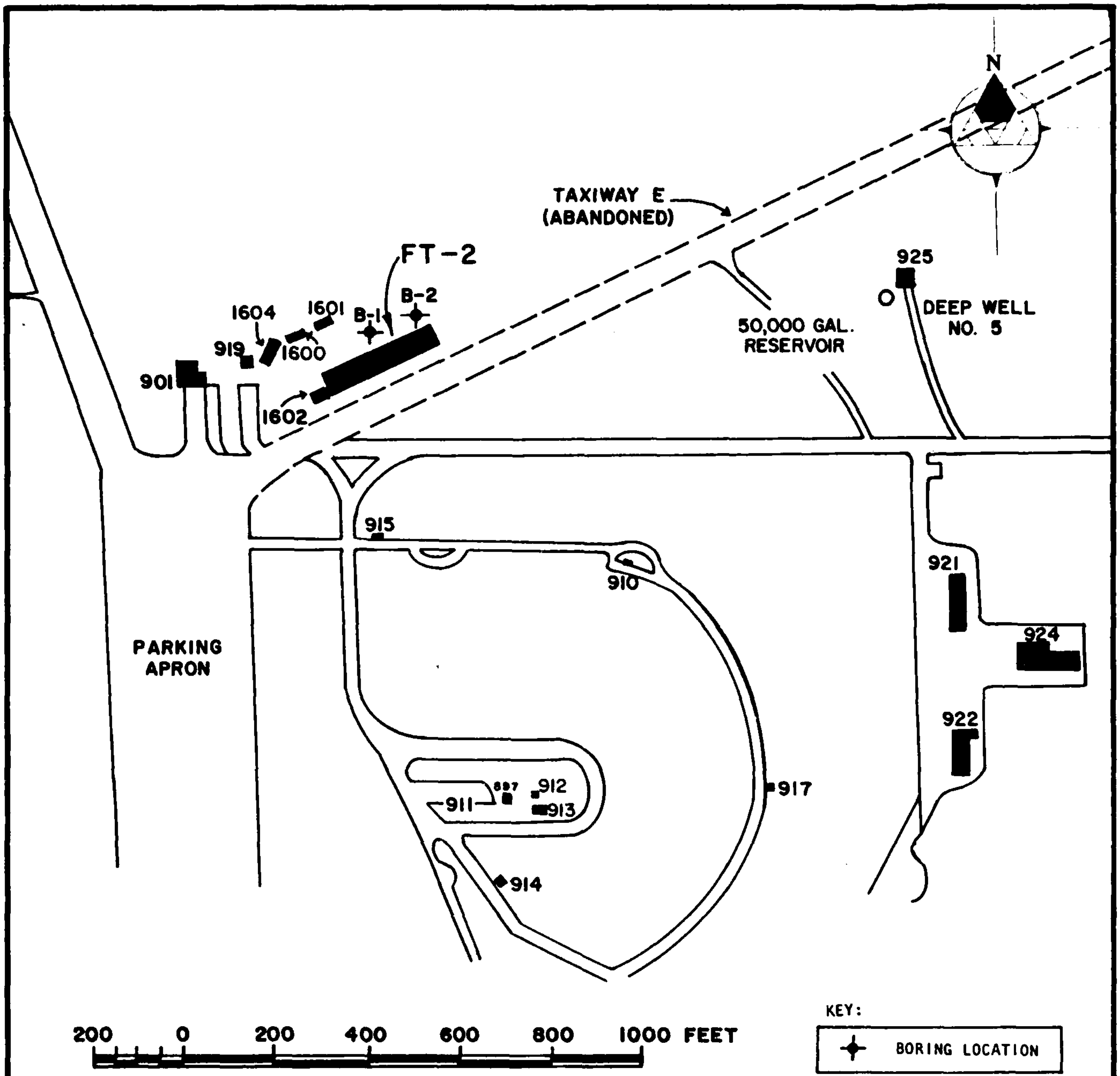
3. Site 5

Washing and painting of aircraft occurred near Site 5 from 1942 to 1982 (Plate 10). Three borings were drilled, sampled, and logged near this site.

Subsurface materials at Site 5 consisted of interbedded silty sand and sandy clay with some coarse sand layers (see Appendix C). Water was encountered at the surface in borings B-1 and B-2. Boring B-3, which ended at 11.5 feet, was dry. Percent moisture in analyzed soil samples ranged from 15 to 20 percent. HNU photoionization meter readings were at background levels during drilling.

E. HISTORIC GROUND WATER PROBLEMS

Ground water in the vicinity of Buckley ANGB provides water for domestic, agricultural, industrial, and commercial uses. Up to 100 feet of decline in the water table has been reported for the area around Buckley ANGB during 1958 through 1978. This water level decline is due to increased pumpage in the developing Denver suburban areas and to the spread of the decline of water levels from the metropolitan area (Robson and Romero, 1981).

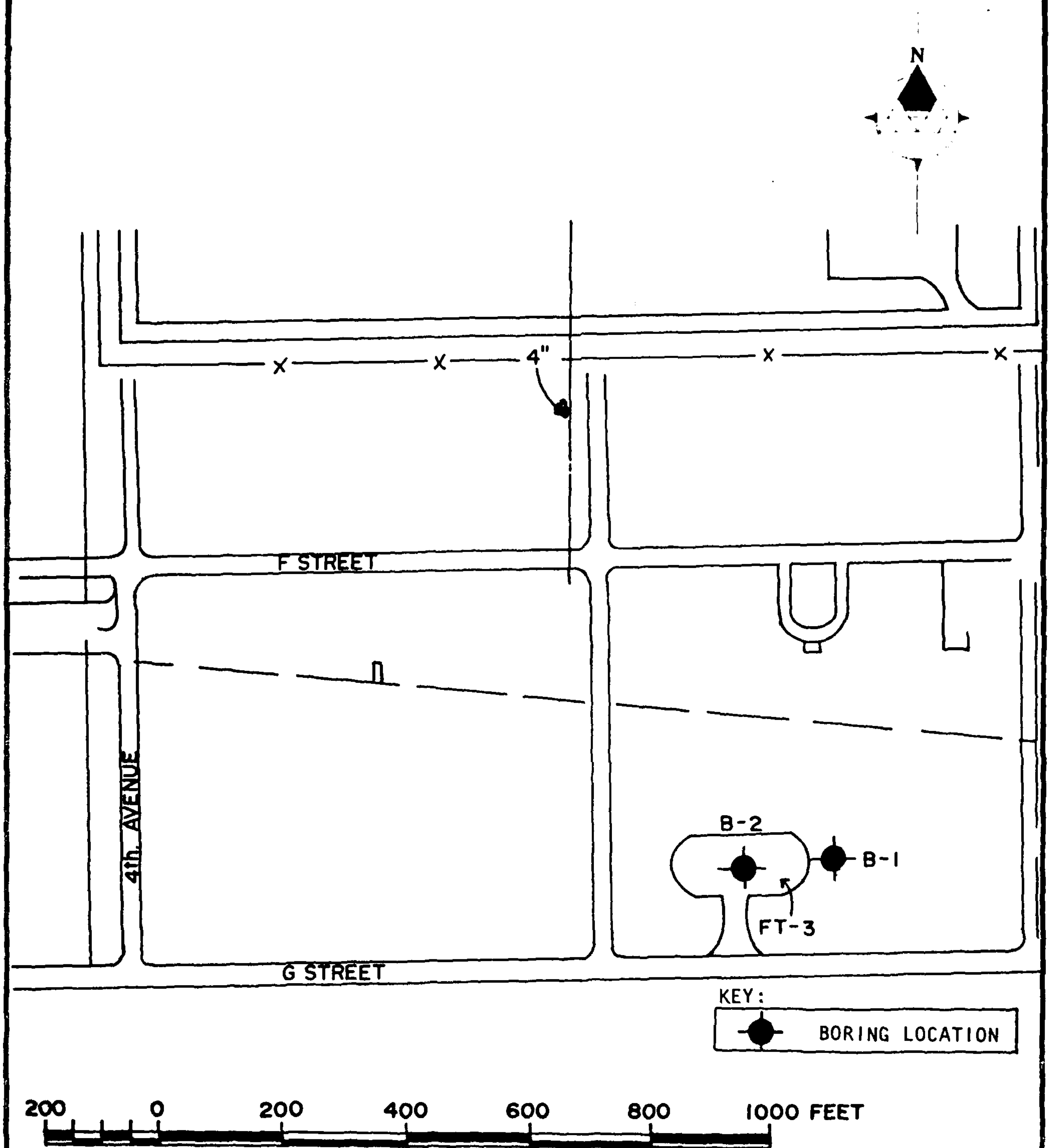


LOCATION OF SITE 2, FT-2
FIRE TRAINING AREA - 2
BUCKLEY ANGB

SOURCE: BUCKLEY ANGB DEVELOPMENT PLAN MAP, 1984

Dames & Moore

PLATE 7

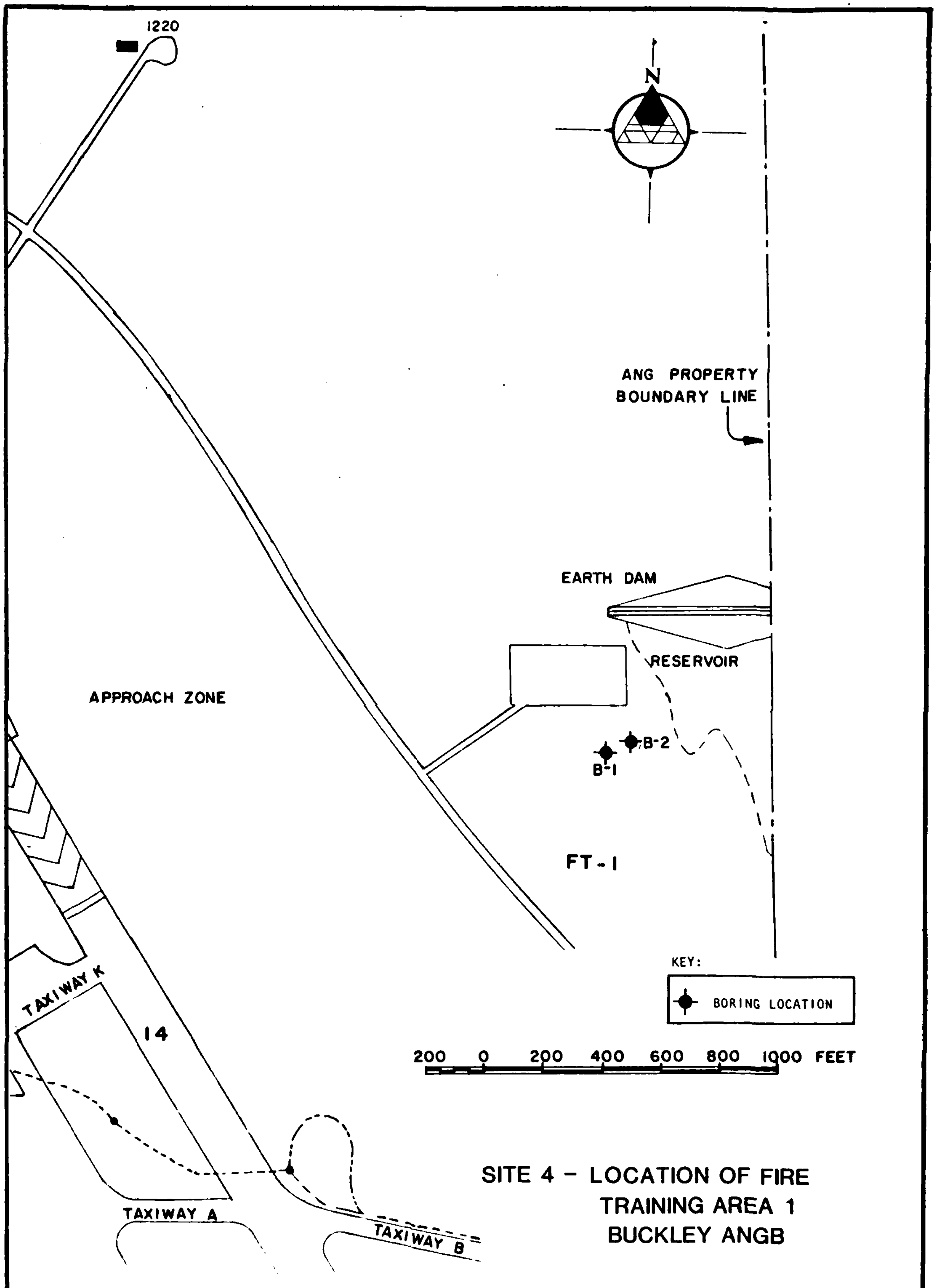


LOCATION OF SITE 3
FIRE TRAINING AREA - 3
BUCKLEY ANGB

SOURCE: BUCKLEY ANGB DEVELOPMENT PLAN MAP, 1984

Dames & Moore

PLATE 8

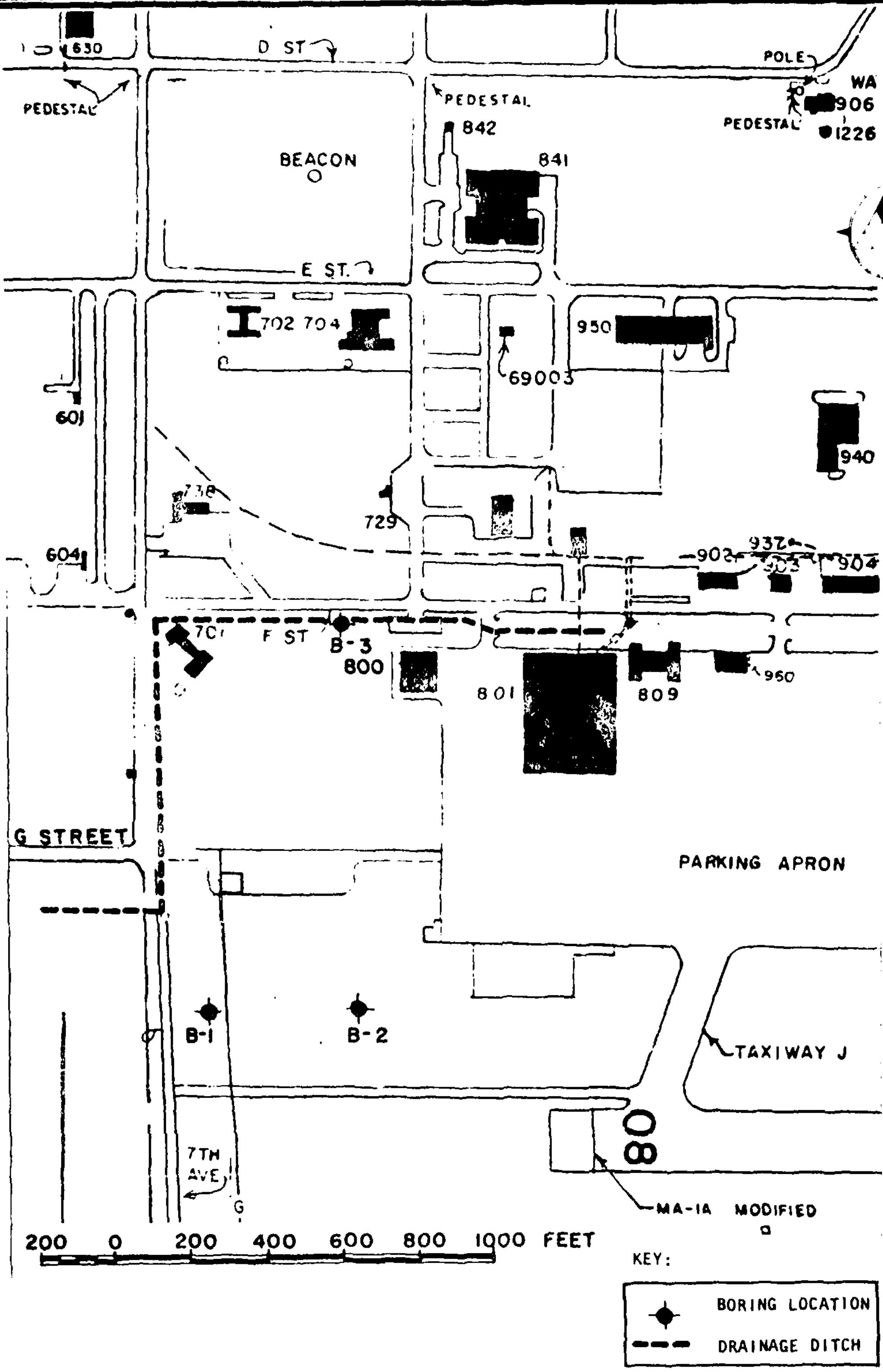


SITE 4 – LOCATION OF FIRE
TRAINING AREA 1
BUCKLEY ANGB

SOURCE: BUCKLEY ANGB DEVELOPMENT PLAN MAP, 1984

Dames & Moore

PLATE 9



SITE 5
DRAINAGE DITCH NEAR BUILDING 801
BUCKLEY ANGB

SOURCE: BUCKLEY ANGB DEVELOPMENT PLAN MAP, 1984

Dames & Moore

PLATE 10

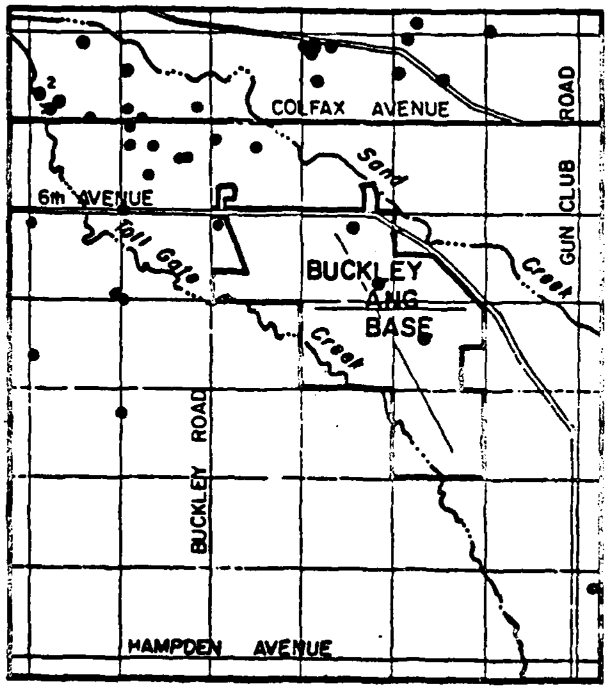
Ground water quality is generally good in the Denver and Arapahoe aquifers and meets the U.S. Environmental Protection Agency (USEPA) drinking water standards. The water withdrawn from the Denver and Arapahoe aquifers in the Buckley ANGB area generally has about 200 mg/L of dissolved solids, less than 25 mg/L of dissolved sulfate, and the water is generally soft with less than 60 mg/L of calcium carbonate. The Phase I investigation reported chemical analysis of water drawn from the Buckley deep wells and the Marine well that showed excessive fluoride, but no other constituents exceed drinking water limits. Hillier et al. (1983) have reported high levels of fluoride for the Denver and Arapahoe aquifers as discussed in Section IV.A.6. The water at Buckley is reported to have taste and odor problems. Water drawn from the Laramie and Fox Hills aquifers may have troublesome amounts of methane and hydrogen sulfide, which can cause foul tastes and objectionable odors. Laramie-Fox Hills water also has been reported to have excessive iron and fluoride concentrations (Simons, Li & Associates, 1982).

Ground water samples were taken from wells on Buckley ANGB during the Presurvey Site Tour (26 March 84). The analyses of these water samples are discussed in Section IV.A.4.

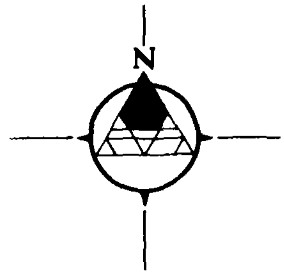
F. LOCATION OF WELLS ON AND OFF BASE

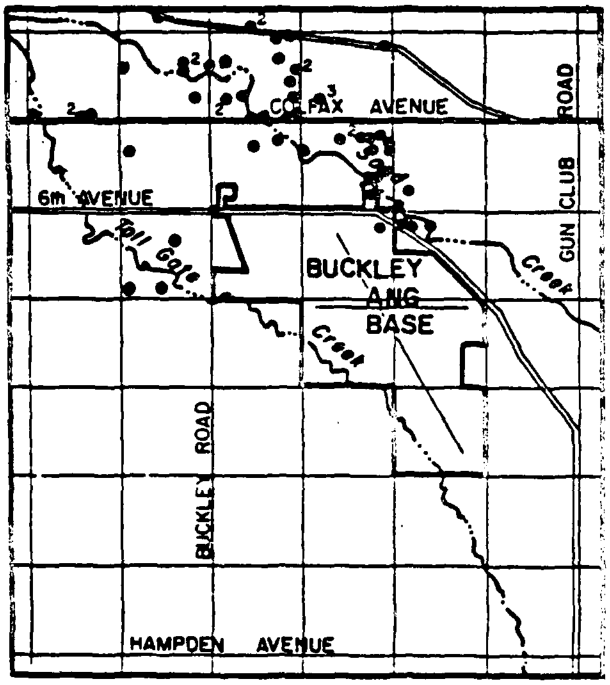
Buckley ANGB derives its water supply from on-base wells. The locations of the on-base wells are shown on Plate 2. Well No. 1 is no longer in operation, and well No. 2 has collapsed.

Approximately 40 wells tap ground water north and west of Buckley ANGB (Plate 11). Ground water usage has declined in the area due to urbanization and the availability of city water supplies, but many domestic and ranch wells are still in use.



LOCATION OF WELLS TAPPING CONSOLIDATED (BEDROCK) MATERIALS





LOCATION OF WELLS TAPPING UNCONSOLIDATED (ALLUVIAL) MATERIALS

● Location of well

2 Number of wells in same location

Source: Colorado State Engineer

LOCATIONS OF RECORDED WELLS IN THE BUCKLEY ANG BASE AREA

SOURCE: MODIFIED FROM SIMONS, LI & ASSOCIATES, INC., 1982

Dames & Moore

PLATE II

III. FIELD PROGRAM

A. DEVELOPMENT

The field program was developed based on Phase I and the Phase II Presurvey of the IRP. During Phase I, the sites at which hazardous materials were handled were identified, and the sites with potential environmental impact were selected. The Phase II, Stage 1 field program consisted of the following activities:

1. Drilling, soil sampling, geologically logging, and installing and developing four new monitor wells at Site 1 on the base;
2. Measuring water levels and collecting samples for water quality analyses from each new monitor well;
3. Drilling, soil sampling, and geologically logging nine boreholes at four sites on the base; and
4. Chemical analysis of soil and water samples.

B. IMPLEMENTATION

1. Well Installation

Four monitor wells were constructed at Site 1 on Buckley ANGB. The wells were constructed by Custom Auger Drilling Services, Inc. of Denver, Colorado under the direction of Dames & Moore field personnel, using a truck-mounted rotary drill rig with 8-inch hollow stem augers. Samples were collected using a 2.5-inch split spoon sampler driven by a 340-pound drop hammer. The sampler was thoroughly cleaned with a weak nitric acid solution, hexane, and distilled water before each sampling. Descriptions of the samples were made in the field by an experienced Dames & Moore technician, and these descriptions were used to prepare geologic logs for each borehole.

The boreholes were monitored for explosive gases during drilling using an explosimeter. Readings were taken at the top of the borehole during drilling and immediately before sampling operations. The readings were recorded in a field notebook.

The casing installed for the monitor wells was a nominal 2-inch Schedule 40 PVC pipe and well screen. The screen is 0.010-inch slot size with a 0.25-inch space between slots. All casing and screen sections were coupled with threaded joints; no PVC solvent or metal parts were used. Where possible, wells had 25 feet of screen set so that the upper 5 feet of screen extended above the water table. Above the screen, blank casing was installed to a nominal 1 to 2 feet above the ground

surface. Monitor well MW-1 had 10 feet of screen installed at a depth of 68 feet. It is believed that a perched zone of water was encountered at 40 feet. The installation record for each well is provided in Appendix C, and a summary of construction details is given in Table 2.

A gravel pack was placed in the annular space from the bottom of the well to the top of the well screen. The remainder of the annular space was filled with a cement-bentonite mixture to about 1.5 feet from the ground surface. A concrete cap was poured to the ground surface, and the installation was completed by embedding a 3-foot length of 6-inch diameter steel pipe with a locking cap approximately 1.5 feet into the concrete cap and over the well pipe.

2. Well Sampling

After drilling, each well was developed by bailing until the water became clear or until it was obvious that further effort would not improve the clarity of water being discharged. Prior to sample collection, another three well volumes were removed by bailing. Temperature, specific conductance, and pH measurements of the water were made after bailing was completed. Samples were collected from the wells using a PVC sampling bailer. The bailer was suspended in the well using a polypropylene rope and was raised and lowered by hand. Prepared sampling containers, with appropriate preservatives, were filled and immediately stored on ice in insulated shipping containers. At the end of each sampling day, the water samples were shipped via air freight to the testing laboratories (UBTL in Salt Lake City, Utah, and OEHL at Brooks AFB, Texas), where the samples were received the following day. The soil samples were stored in prepared glass containers and frozen at the end of each working day. They were shipped to the testing laboratories at the same time the water samples were shipped.

The bailer and the various probes and containers used during sampling and field testing were thoroughly rinsed after each use with laboratory-grade detergent and water, hexane, and distilled water, in that order. All field instruments functioned well and were calibrated before and during use to ensure accuracy. Static water levels were measured during drilling operations and again during sampling.

Chain-of-custody forms were prepared and accompanied the samples from the field to the laboratory. These records documented the integrity of the samples at each point of transfer, from field personnel to shippers and couriers to the laboratory staff. The signatures of the individuals relinquishing and accepting custody of the samples and the date and time appear on the records at each point of transfer (see Appendix G).

3. Analytical Methods

The soil and ground water samples were analyzed in accordance with USEPA methods. Table 1 lists each parameter and site of the chemical analysis scheme. Tables 3 and 4 list each parameter and its analytical method. Details of sampling and analytical procedures are provided in Appendix E.

TABLE 3

ANALYTICAL RESULTS ABOVE DETECTION LIMIT
BUCKLEY ANGB - WATER ANALYSES

			DETECTION	SITE 1		
PARAMETER	METHOD	UNIT	LIMIT	MW-1	MW-3	MW-4
Cadmium	213.1[a]	mg/L	0.01	0.02	0.02	0.01
Nickel	249.1[a]	mg/L	0.05	0.08	0.09	0.09
Silver	272.1[a]	mg/L	0.01	0.02	0.02	0.01
Phenolics	420.2[a]	μg/L	10.	10.	30.	10.
TDS	160.2[a]	mg/L	1.	3500.	2300.	2500.
TOC	415.1[a]	mg/L	1.	6.1	39.	6.4
TOX	9020[b]	μg/L	10.	64.	65.	63.
pH	field	--	--	6.9	6.8	6.8
Temperature	field	°C	--	13.8	13.0	12.0
Specific Conductance	field	μmhos/cm	--	4651.	2852.	2772.

[a]Methods for Chemical Analysis of Water and Wastes, EPA 600/4-79-020, revised March 1983.

[b]Test Methods for Evaluating Solid Waste, SW-846, 2nd ed., July 1982, modified for use on O.I. Corp. Model 610 TOX analyzer.

Notes: 1. The analytical technique between the methods published in EPA-SW-846, EPA 600/4-82-057, EPA 600/4-79-020, and Standard Methods 16th ed. are the same.

2. Water samples were analyzed for chromium, lead, aldrin, DDD, DDE, o,p-DDT, p,p'-DDT, dieldrin, endrin, heptachlor, heptachlor epoxide, lindane, methoxychlor, 2,4-D, 2,4,5-TP, and 2,4-T and were found to be below the limits of detection.

TABLE 4

ANALYTICAL RESULTS ABOVE DETECTION LIMIT
BUCKLEY ANGB - SOIL ANALYSES[a]

PARAMETER	METHOD	UNIT	DETECTION LIMIT	SITE 1 MW-4 #1 0-1.5'	MW-4 #3 5-6.5'	MW-4 #5 15-16.5'	MW-3 #1 0-1.5'	MW-3 #3 5-6.5'	MW-3 #5 15-16.5'	MW-1 20-20.5'	MW-2 43-43.5'
% Moisture	160.3[b]	%	1.	15.	8.	21.	13.	9.	22.	10.	10.
Phenolics	420.2[b]	µg/g	1.	d	d	d	d	3.	d	8.	5.
TOC	415.1[b]	µg/g	5.	4100.	1400.	2900.	3700.	2400.	2700.	1200.	870.
TOX	9020[c]	µg/g	5.	d	d	d	d	d	d	d	d

PARAMETER	METHOD	UNIT	DETECTION LIMIT	SITE FT-2 B-1 #1 0-1.5'	B-1 #3 5-6.5'	B-2 #1 0-1.5'	B-2 #3 5-6.5'	SITE FT-3 B-1 #1 0-1.5'	B-1 #3 5-6.5'	B-2 #1 0-1.5'	B-2 #3 5-6.5'
Lead	239.1[b]	µg/g	10.	47.	39.	40.	43.	20.	37.	45.	29.
% Moisture	160.3[b]	%	1.	16.	16.	15.	19.	11.	11.	9.	4.
Phenolics	420.2[b]	µg/g	1.	2.	d	3.	d	6.	5.	4.	3.
TOC	415.1[b]	µg/g	5.	5700.	1900.	4200.	1500.	5800.	4300.	3700.	1500.
TOX	9020[c]	µg/g	5.	d	d	d	d	8.6	d	d	d

PARAMETER	METHOD	UNIT	DETECTION LIMIT	SITE FT-1 B-1 #1 0-1.5'	B-1 #3 5-6.5'	B-2 #1 0-1.5'	B-2 #3 5-6.5'
Lead	239.1[b]	µg/g	10.	34.	34.	44.	31.
% Moisture	160.3[b]	%	1.	13.	11.	6.	13.
Phenolics	420.2[b]	µg/g	1.	7.	10.	1.	d
TOC	415.1[b]	µg/g	5.	2200.	1100.	4900.	2600.
TOX	9020[c]	µg/g	5.	d	d	d	d

PARAMETER	METHOD	UNIT	DETECTION LIMIT	SITE 5 B-1 #1 0-1.5'	B-1 #3 5-6.5'	B-2 #1 0-1.5'	B-2 #3 5-6.5'	B-3 #1 0-1.5'	B-3 #3 5-6.5'
Lead	239.1[b]	µg/g	10.	38.	25.	77.	38.	34.	24.
% Moisture	160.3[b]	%	1.	17.	15.	19.	18.	20.	15.
Phenolics	420.2[b]	µg/g	1.	d	1.	1.	d	d	3.
TOC	415.1[b]	µg/g	5.	3300.	400.	4800.	2400.	4200.	1900.
TOX	9020[c]	µg/g	5.	d	d	d	d	d	d

[a]Results corrected for percent moisture.

[b]Methods for Chemical Analysis of Water and Wastes, EPA 600/4-79-020, Revised March 1983, modified for use with soil samples.

[c]Test Methods for Evaluating Solid Waste, SW-846, 2nd ed., July 1982, modfified for use on O.I. Corp. Model 610 TOX Analyzer, with soil samples.

[d]Denotes value less than the limit of detection.

IV. DISCUSSION OF RESULTS AND SIGNIFICANCE OF FINDINGS

This section presents a discussion of the chemical analyses of soil and ground water samples collected during field investigations at the sites shown on Plate 6. The second portion of this section discusses the significance of the results. Site-specific geology is discussed in Section II, and the field investigations are described in Section III.

Water samples were analyzed for pH, temperature, specific conductance, cadmium, chromium, lead, nickel, silver, phenolics, total dissolved solids (TDS), total organic carbon (TOC), total organic halogens (TOX), and 14 pesticides. Table 3 lists results of those analyses that were above detection limits. Appendix G contains the complete analytical report for water and soils. Soil samples were analyzed for percent moisture, phenolics, TOC, and TOX at all sites, and for lead (by acid extraction) at FT-1, FT-2, FT-3 and Site 5. At Site 1, soils were also analyzed for 14 pesticides. Table 4 lists results of soils analyses that were above detection limits.

A. DISCUSSION OF RESULTS

1. Site 1

Four monitor wells were installed in the area of the landfill and oil pit. Two upgradient wells, MW-1 and MW-2, were placed on a hill south of the zone (Plate 6). After installation and development to depths of 68 feet, it was discovered that neither well penetrated the true water table. MW-2 was dry, and MW-1 probably drains a perched water-bearing lens. MW-3 and MW-4 are believed to be downgradient from the oil pit and landfill, respectively.

The primary drinking water standard for cadmium (0.01 mg/L) was exceeded in the three wells sampled (see Table 3). Chromium, lead and the fourteen pesticides (aldrin, DDT isomers and derivatives, dieldrin, endrin, heptachlor, epoxide, lindane, methoxychlor, 2,4-D, 2,4,5-TP, and 2,4-T) were below detection limits in all three wells, but the very low percent recovery for lead (7 percent) makes this result questionable (see Appendix G). A suspected matrix effect has resulted in greatly underestimated lead values. Total dissolved solids (TDS) were high in the three wells, ranging from 2300 mg/L in MW-3 to 3500 mg/L in MW-1. Correspondingly, specific conductance was high. Total organic carbon (TOC) was relatively high, at 39 mg/L, in MW-3 as compared to MW-1 and MW-4 where it was 6.1 mg/L and 6.4 mg/L, respectively. Phenolics were also higher in MW-3 (30 μg/L) than in MW-1 or MW-4 (10 μg/L in both). Total organic halogens (TOX), which ranged from 63 μg/L to 65 μg/L, were slightly elevated in all the wells. Nickel and silver were

detected at low concentrations. The pH level, at 6.8 and 6.9, was within the acceptable range of 6.5 to 8.5 as stated in the secondary drinking water regulations (40 CFR 143, 1979).

The eight soil samples from the monitor wells had no detectable TOX or pesticides. Phenolics in the soil were not detected downgradient of the site (see Table 4) and ranged from 5 to 7 μg/g upgradient of the site. TOC was 1200 and 870 μg/g at depth in MW-1 and MW-2, respectively; in MW-4 and MW-3, TOC ranged from 1400 to 4100 μg/g. A spongy black organic silt with fibers was found in MW-3 and MW-4 at 15 feet, and TOC values of 2700 and 2900 μg/g, respectively, were detected in these borings.

2. Sites FT-1, FT-2, and FT-3

Two borings were placed at FT-2, the fire training area near the control tower and base well No. 5 (see Plate 7). TOX was below detection limits in the soil samples from B-1 and B-2, and phenolics were detected only at the surface in very low amounts (2 and 3 μg/g) (see Table 4). Lead levels were about four times the detection limit in the soil samples, but the low recovery rate (3 percent) because of matrix effects makes all the lead results uninterpretable (see Appendix G). A matrix effect occurs when the lead is not liberated completely during the analysis and, therefore, the measured values are lower than expected in the spike analyses. TOC ranged from 1500 μg/g at 5 feet in B-2 to 5700 μg/g at the surface in B-1.

FT-3 is the fire training area near Building 801 (see Plate 8). A fuel odor was noted during drilling of both B-1 and B-2. TOX was detected in the soil at B-1 at the surface (8.6 μg/g) but was below detection limits elsewhere. Phenolics in the soil ranged from 3 μg/g in B-2 at 5 feet to 6 μg/g in B-1 at the surface. TOC was 5800 and 4300 μg/g at the surface and at 5 feet, respectively, in B-1; it was 3700 and 1500 μg/g in B-2.

FT-1, the fire training area near the reservoir, was sampled in two soil borings, B-1 and B-2 (see Plate 9). No fuel odor was noted during their drilling. TOX was below detection limits in the soil samples from B-1 and B-2 (see Table 4), and phenolics ranged from 1 μg/g in B-2 to 10 μg/g in B-1. TOC ranged from 1100 μg/g at 5 feet in B-1 to 4900 μg/g at the surface in B-2.

3. Site 5

This site of aircraft painting and washing was sampled in three soil borings, B-1, B-2, and B-3 (see Plate 10). TOX was below detection limits in all the soil samples from these borings (see Table 4); phenolics ranged up to 3 μg/g in B-3. TOC ranged from 400 μg/g at 5 feet in B-1 to 4800 μg/g at the surface in B-2.

4. Results of Base Well Sampling

Ground water samples were taken from wells on the base during the Presurvey Site Tour (26 March 84). The samples were analyzed for pH, temperature, specific conductance, oil and grease, TOC, and TOX. Table 5 lists the results of those analyses. Specific conductance was elevated in base wells No. 5 and No. 3. Oil and grease and TOC were below detection limits in all wells. TOX ranged from 40 to 50 μg/L.

5. Reliability of Ground Water and Soil Analyses

The ground water quality analyses are considered to be reliable by virtue of the well construction and sampling measures taken in the field to insure that the samples were representative; by virtue of quality control procedures in the laboratory; and because of the monitor well locations.

The monitor wells were screened above and below the water table where low density organic contaminants would be concentrated. After the monitor wells were installed, they were developed by bailing to lower the effects of drilling and installation and to improve the flow of ground water into the wells. At least three casing volumes of water were removed from the monitor wells prior to sampling to insure that the samples were representative of ground water in the formation. The monitor well samples were collected with a PVC bailer to minimize agitation and consequent aeration of the sample, which could volatilize organic chemicals.

The downgradient monitor wells were installed at locations where they would most likely intercept contaminants from the landfill and oil pit. Soil borings were placed within the fire training areas and, at Site 5, adjacent to and downhill from the wash area.

The laboratory quality control (QC) program is described in detail in Appendix B. In general, analyses of duplicate and spiked samples were satisfactory, except for the lead and TOX analyses. The recovery rates for the lead analysis were 7 percent from the water sample and 3 percent from the soil samples. In the TOX analysis, the recovery rate was 52 percent from the soil sample. A matrix effect was suspected to be the cause of the low recovery rates in both cases.

TABLE 5

GROUND WATER QUALITY FROM BASE WELLS

WELL	ELEVATION (ft MSL)	DEPTH (ft)	pH[a]	TEMPERATURE (°C)	CONDUCTIVITY (μmhos/cm)	OIL & GREASE[b] (mg/L)	TOC[c] (mg/L)	TOX[d] (μg/L)
Base Well 2nd Command	not available	1120	8.1	25	230	<0.7	<1	50
Marine Well (Denver Aquifer)	5680.00	765	8.5	23	220	<0.7	<1	40
Base Well No. 5	5592.00	2100	8.4	28	486	<0.7	<1	50
Base Well No. 3	5562.86	2100	8.3	27	940	<0.7	<1	50

Notes: 1) Well No. 1 could be sampled but it's stagnant ~1100 feet.
2) Well No. 2 collapsed.

[a] 1979 USEPA Quality Criteria for Water, Domestic Water Supply, pH 5 - 9.

[b] Limit of detection = 0.7 mg/L.

[c] Limit of detection = 1 mg/L.

[d] Limit of detection = 10 μg/L.

6. Background Concentrations

No historic background concentrations of organic parameters or pesticides are available for ground water beneath Buckley ANGB, but some information exists for concentrations of inorganic constituents. Ground water used at the base is from the Denver, Arapahoe and Laramie-Fox Hills aquifers. Water quality in all three of these aquifers is generally good but, as discussed in Section II.E, the water at Buckley is reported to have taste and odor problems. Naturally occurring dissolved iron, hydrogen sulfide and methane gas can cause objectionable taste and odors in the aquifers at Buckley.

Table 6 summarizes the water quality in the Denver and Arapahoe aquifers. State standards for public water supplies are often exceeded in these aquifers, especially for total dissolved solids, manganese and sulfate. As discussed in Section II.E, these aquifers generally have about 200 µg/L total dissolved solids and less than 25 µg/L dissolved sulfate.

No historic analyses of the organic content of ground water beneath the base were available, and the absence of any water quality criteria for TOX and TOC precludes any regulatory basis for comparing the concentrations obtained from water and soil samples. However, the following information provides some basis for interpreting the quality of water and soil indicated by TOX and TOC measurements.

TOC is a measure of the organic carbon in a sample, regardless of whether the source is natural or man-made. Organic carbon in uncontaminated ground water is derived from humic and fulvic acids dissolved from sediments, dissolution of carbonates containing organic carbon, and other dissolved organic materials. Background concentrations are typically less than 10 mg/L. In an aquifer in which there is little ground water movement, organic-rich aquifer material, and relatively anaerobic or reducing conditions, TOC concentrations could be expected to range up to 100 mg/L. Industrial wastes may contain as much as 200,000 mg/L, and consequently, highly contaminated ground water may yield any concentration including several thousand milligrams per liter of TOC.

All soils contain varying fractions of organic materials that, in turn, contain different concentrations of organic carbon. The organic carbon analyses for the Buckley ANGB samples were performed on soil slurried with water and analyzed using the TOC methodology (USEPA Method 415.1) for water. No TOC methodology for solid samples has been approved by USEPA to date. The Buckley soil analyses will be evaluated only on a relative basis, especially because no background samples were specified by the Phase II, Stage 1 scope of work.

TABLE 6

SUMMARY OF SELECTED CHEMICAL CONSTITUENTS IN WATER FROM WELLS

			DENVER AQUIFER				ARAPAHOE AQUIFER			
			RANGE				RANGE			
CONSTITUENT	UNIT	STANDARD	LOW	HIGH	NUMBER OF SAMPLES	NUMBER OF SAMPLES WHERE STANDARD EXCEEDED	LOW	HIGH	NUMBER OF SAMPLES	NUMBER OF SAMPLES WHERE STANDARD EXCEEDED
Dissolved solids	mg/L	500[a]	175	7110	27	17	343	1920	4	7
Dissolved arsenic	µg/L	50[b]	<1		1	0	<1		1	0
Dissolved chloride	mg/L	250[a]	3.0	3050	27	3	37	85	4	0
Dissolved fluoride	mg/L	1.8[b]	0.2	2.0	8	2	1.0	4.2	4	1
Dissolved iron	µg/L	300[a]	<1	6900	21	3	70	150	3	0
Dissolved magnesium	mg/L	125[a]	0.2	180	20	1	0.2	80	4	0
Dissolved manganese	µg/L	50[a]	<1	12500	19	6	30	100	2	1
Dissolved nitrite plus nitrate as N	mg/L	10[b]	0.00	3.5	27	0	0.00	8.4	4	0
Dissolved selenium	µg/L	10[b]	8		1	0	20		1	1
Dissolved sulfate	mg/L	250[a]	1.7	1190	22	14	3.3	980	4	3
Hardness, as $CaCO_3$	mg/L	none	32	3870	27	--	30	696	4	--

[a]Recommended state standards for public water supplies (Colorado Department of Health, 1971); with exception of magnesium, standards are the same as the recommended federal standards established for public water supplies (U.S. Environmental Protection Agency, 1977); no recommended federal standard for magnesium.

[b]Primary (mandatory) state standards for public water supplies (Colorado Department of Health, 1977); standards are the same as the mandatory federal standards established for public water supplies (U.S. Environmental Protection Agency, 1976); standard for fluoride based on annual average of maximum daily air temperatures in the study area.

Source: Hillier et al., 1983.

TOX is a measure of organic halogens containing chlorine, bromine, and iodine that can be adsorbed by activated carbon. The same methodology (USEPA Method 9020) was used for both soil and water analyses. A water extract was taken from the soil samples according to USEPA methods (USEPA, 1982). Chlorinated and brominated organic chemicals are not naturally produced, but are manufactured chemicals such as pesticides, PCBs, PBBs, and solvents. Therefore, virtually any concentration of TOX is an indication of contamination. There are no established safe levels of TOX because of the wide variety of compounds that contribute to TOX.

B. SIGNIFICANCE OF FINDINGS

Based on the results described in the previous section, this section will estimate, to the degree possible, the extent of contamination at each site and the risk to human health, if any, that the contamination poses.

1. Extent of Contamination at Site 1

Cadmium contamination in the ground water has been detected at 0.02 mg/L in monitor wells MW-1 and MW-3. In MW-4, cadmium was present at the limit of detection (0.01 mg/L), which is the maximum level of the primary drinking water standard. Because cadmium and elevated TOX (63 to 65 µg/L) are present in both the upgradient and downgradient wells, the current data indicate that the landfill is not the source of these contaminants. The slightly elevated TOC and phenolics in MW-3 suggest contamination from the oil pit may have reached MW-3, but it is possible the elevated TOC in the ground water may be due to the organic silt at 15 feet (see boring logs, Appendix C). The phenolics are likely from the oil pit or the area upgradient of it.

Results of soil analyses did not indicate contamination by phenolics or organic halogens on this site. TOC values are variable; in MW-3 and MW-4, they do not fall with increasing depth, as expected, but fall from zero to 5 feet and go up again at 15 feet, probably because of the organic stratum (see Table 4). The organic silt layer is probably a wetland soil that was buried during an earlier depositional stage of East Toll Gate Creek.

Preliminary information about ground water flow direction near the landfill and oil pit is insufficient to draw conclusions about the extent or potential of contamination from this site. Although regional ground water flow is to the north-northwest, locally the ground water may be flowing toward East Toll Gate Creek and discharging to the alluvial aquifer. In that case, rapid dilution and migration of contaminants would be expected. The water supply of downgradient users of the

alluvial aquifer, some of whom are within 2 miles of the landfill, could be affected by changes in water quality from Site 1. Alternatively, the alluvial aquifer may be acting as a recharge area rather than a discharge area for the bedrock aquifer. In that case, contaminants would move downward into the bedrock aquifers. The water supply on and off base would be affected.

MW-3 and MW-4 are located on a low terrace of East Toll Gate Creek. They are screened in both the alluvium and the bedrock and, therefore, may be giving us information on both water level and water quality that is a composite of the two aquifers. Definitive answers about flow direction and recharge versus discharge areas would require separation of this composite effect.

2. Extent of Contamination at Sites FT-1, FT-2, and FT-3

Results of soil analyses fail to indicate contamination by phenolics or TOX at Site FT-2. As expected in a natural, uncontaminated area, TOC values are higher at the surface (5700 and 4200 μg/g), where plants and roots add to the carbon content of the soil, than they are at depth (1900 and 1500 μg/g). As discussed previously, the lead content of the soil is undetermined because of the low percent recovered from the analysis. No contamination has been documented by the results of these analyses.

The proximity of Site FT-2 to base well No. 5 is of minimal concern because the well is very deep (2100 feet) and because ground water flow from Site FT-2 is generally to the north and away from well No. 5. Ground water flowing from this site would probably discharge to the alluvial aquifer along Sand Creek, where mixing and relatively rapid flow would occur. The potential for contaminant migration to water supply wells from Site FT-2 is probably small.

Contamination of the soil at Site FT-3 was indicated by a strong fuel odor during drilling and by elevated TOX (8.6 μg/g) in B-1. As discussed earlier, lead results are inconclusive.

Ground water flow at Site FT-3 is probably locally to the southwest, towards East Toll Gate Creek. No analyses of ground water were done at this site; therefore, the extent of contaminant migration cannot be estimated. However, there is a potential for impact on downgradient users of the alluvial aquifer, some of whom are within 1 mile of the site.

Results of soils analyses at FT-1 failed to reveal any phenolic or TOX contamination, and TOC concentrations were lower at depth. Lead results were inconclusive.

Ground water was not analyzed at Site FT-1, but flow in this area is probably to the east-northeast, towards the reservoir and its discharge. Any contamination in the ground water moving from this site would likely be diluted by the reservoir before discharge to the Sand Creek alluvial aquifer. The potential for effect on water supply wells is probably small.

3. Extent of Contamination at Site 5

Results of soil analyses from Site 5 do not indicate TOX or phenolics contamination, and the lead results are inconclusive. TOC levels, as expected, drop with depth.

Site 5, like Sites 1 and FT-3, is located in an area that drains to East Toll Gate Creek. Although the results of soils analyses to date do not indicate contamination at this site, migration from this area could affect nearby downgradient users of the alluvial aquifer.

4. Extent of Contamination of Base Wells

Results of analyses performed on water from base wells yielded TOX concentrations of 40 to 50 µg/L. To determine whether these values are caused by man-induced pollutants or are attributable to a matrix effect due to naturally occurring halogens, particularly chlorides, it will be necessary to reanalyze water from these wells by USEPA Methods 601 and 602, as well as for chloride. Determination of the extent of contamination, if present, can be made only after these specific analyses are performed.

V. ALTERNATIVE MEASURES

A. ALTERNATIVE MEASURES

This section describes several alternatives for further defining the extent and magnitude of ground water and soil contamination that has been found at Buckley ANGB. The alternatives include additional soil and ground water analyses, a resistivity survey, and installation of seven additional wells. Each alternative is discussed below.

Additional soil analyses at Sites FT-1, FT-2, and Site 5 are necessitated by the inconclusive results of the lead analyses for this study. Analytical problems, specifically a recovery rate of less than 10 percent caused by a suspected matrix effect, made results of the earlier lead analyses uninterpretable. An EP toxicity test leaching procedure, using acidified water to leach the soil, and the method of standard additions to analyze for the lead should result in meaningful data about possible lead contamination and its mobility at these sites.

A resistivity survey of Site 1, the landfill and oil pit zone, calibrated with a small number of wells, should provide a cost-effective subsurface investigation of the extent of the contaminant plume from this site. TDS levels in MW-3 and MW-4 suggest, preliminarily, that there is sufficient resistivity contrast between the landfill plume and the aquifer. This contrast makes the contaminant plume identifiable from the surface and precludes the necessity of a large number of costly wells. One upgradient and three downgradient wells, placed relative to the plume as defined by the resistivity survey and sampled for indicator parameters and volatile organics, can provide information on the magnitude of the contamination from this site. These wells and MW-1, MW-3, and MW-4 should be analyzed for TDS, pH, specific conductance, temperature, phenolics, purgeable halocarbons (USEPA Method 601), and purgeable aromatics (USEPA Method 602).

The contamination at Site 1 should be verified by resampling for cadmium in MW-1, MW-3, and MW-4 and analyzing using an analytical method that provides a lower detection limit. Cadmium was detected above the primary drinking water standard in MW-1 and MW-3 and at the standard in MW-4, but the detection limit for the analysis was at the standard. Verification should be done with a more sensitive analysis.

In order to determine whether ground water contamination is resulting from the past activities at the fire training areas and at Site 5, monitor wells should be installed downgradient of each of these sites and analyzed for TDS, pH, specific conductance, temperature, lead, cadmium, phenolics, purgeable halocarbons, and purgeable aromatics.

Borehole geophysical methods such as resistivity, self potential, density, and gamma radiation are often used to characterize and correlate geologic and hydrologic conditions. However, they would not yield significantly more subsurface information than that collected during the drilling and sampling carried out for Phase II, Stage 1. Like surficial geophysical methods, borehole methods yield the most information from sediments with contrasting properties such as composition, grain size, moisture content, density, or degree of consolidation. The shallow sediments beneath the base consist primarily of interbedded materials of contrasting grain sizes, but in the area of concern, the alluvial aquifer in East Toll Gate Creek, these contrasts are not as likely and borehole measurements would be relatively useless.

Unsaturated zone monitoring is a method of investigation that is used to characterize the quality of water in the soil pores above the water table. The sample is collected in a lysimeter that is buried at some depth beneath the area of investigation. The main disadvantages of lysimeters are that the porous ceramic filter plugs with soil or the hoses break or collapse. Their usefulness at Buckley ANGB would be limited by the lack of infiltrating water because of the high evaporation rate.

B. CONCLUSIONS

The following section contains a summary of the conclusions reached after completion of Phase II, Stage 1. Recommendations for the next phase of the IRP are given in Section VI.

Two bedrock aquifers and an alluvial aquifer are of concern at Buckley ANGB. The alluvial aquifers in this area occur in the present and ancestral stream valleys and terraces. The aquifers associated with East Toll Gate Creek, in the southwest corner of the base, and Sand Creek, north and east of Buckley, may be local ground water discharge areas; both are local water supply sources. Ground water from the bedrock aquifers, the Denver and the Arapahoe, is also an important source of local water supplies both on and off base and is of concern because contaminated water in the upper (Denver) aquifer could flow downward into the the lower (Arapahoe) aquifer. The potential for such contamination of the bedrock aquifers is minimized by the low net precipitation in this area (-30 inches), which reduces input from contamination sites on the surface, and by the complex interbedding of impermeable and low permeability layers in both aquifers, which slows the downward movement of contaminants.

Regional ground water flow direction is to the north and northwest, but locally, shallow ground water in the bedrock may discharge to the alluvial aquifers along the streams. The alluvial aquifers are primarily coarse grained materials;

pollutant attenuation can be expected to be minimal, and downgradient movement is rapid. If the alluvial aquifers act as recharge areas for the bedrock aquifer, the landfill zone and oil pit could affect the bedrock aquifer.

Although the evidence obtained during this investigation from soil samples collected at Sites FT-1, FT-2, and 5 does not give confirmation of contamination originating from these sites, ground water should be analyzed to assess whether an adverse condition exists.

Evidence of contamination has been found at two of the sites studied in this investigation, Site FT-3 and Site 1. At Site FT-3, the soil is contaminated, as evidenced by a strong fuel odor and elevated TOX. At Site 1, the ground water was found to be contaminated by cadmium in levels above the primary drinking water standard. TDS, TOX, TOC, and phenolics were also elevated in MW-3 at this site.

The two contaminated sites at Buckley ANGB could affect the water supply on or off base. Ground water at Sites FT-3 and 1 may discharge to the aquifer associated with East Toll Gate Creek, and downgradient users of this aquifer are within 1 mile of the base. Sites FT-3 and 1 could be affecting the quality of water in this alluvial aquifer. If the alluvial aquifer recharges the bedrock aquifer in this area, Sites 1 and FT-3 may affect water quality in the bedrock aquifers. These aquifers are used for on-base and off-base drinking water supplies.

At this time, only suggestive evidence exists for contamination of base wells. TOX concentrations of 40 to 50 μg/L may be a result of a matrix effect due to high concentrations of naturally occurring halogens, or may be due to man-induced pollutants. Further, more specific analyses are needed to resolve this solution.

VI. RECOMMENDATIONS

The recommendations presented in this section have three primary purposes:

1. To identify those sites where further action is deemed warranted;
2. To confirm the existence and magnitude of contamination beneath the base; and
3. To aid in establishing the distance of migration of contaminants under and off the base.

Various alternative measures for achieving these purposes, along with a discussion of the information that would be obtained, are presented in Section V. The following are our recommendations for sites requiring no further action and sites warranting further investigation. Cost estimates for a recommended Phase II, Stage 2 scope of work are provided in Appendix K (separate cover).

A. SITES WHERE FURTHER ACTIONS ARE DEEMED UNWARRANTED (CATEGORY 1)

Because the preliminary analyses for lead were inconclusive, it is recommended that all the sites investigated in Phase II, Stage 1 be considered for further investigation.

B. SITES WARRANTING FURTHER INVESTIGATION (CATEGORY 2)

For Site 1, the landfill and oil pit zone, several stages of further work are recommended. Contamination in the ground water at this site should be verified by resampling for cadmium using an analytical method with lower detection limits at wells MW-1, MW-3, and MW-4. A resistivity survey of the landfill and oil pit plume, particularly within the alluvial aquifer, is also recommended. Four new monitor wells should be installed, three screened in the alluvial aquifer and one screened in the bedrock aquifer, to determine whether the area around Site 1 is a recharge or a discharge area. These wells will assist in calibrating the resistivity survey. The upgradient well should be located southeast of the landfill along the East Toll Gate Creek drainage. This well should be screened within the alluvium. If permission to install wells off base can be obtained, the three downgradient wells should be positioned northwest of the landfill along East Toll Gate Creek. Two of the wells, one screened in the alluvium and one screened in the bedrock, would be located immediately east of Alameda Avenue. The third well, screened in the alluvium, would be located approximately 500 feet further downgradient along the drainageway. After the resistivity survey is completed, all the wells should be analyzed for TDS, pH, specific conductance, temperature, purgeable halocarbons

(USEPA Method 601), purgeable aromatics (USEPA Method 602), cadmium, phenolics, and lead (Method of Standard Additions, EPA-600/4-79-020, Revised March 1983, Metals, Atomic Absorption Method, ¶8.5).

Monitor wells, two downgradient and one upgradient, are recommended for Site FT-3, where a fuel odor and elevated TOX and TOC indicate the soil is contaminated. These wells should be sampled and analyzed for purgeable halocarbons (USEPA Method 601), purgeable aromatics (USEPA Method 602), TDS, phenolics, pH, temperature, specific conductance, and lead (Method of Standard Additions, EPA-600/4-79-020, Revised March 1983, Metals, Atomic Absorption Method, ¶8.5).

At Sites FT-1, FT-2, and 5, installation of one downgradient well at each site is recommended. These wells should be sampled and analyzed for purgeable halocarbons (USEPA Method 601), purgeable aromatics (USEPA Method 602), TDS, phenolics, pH, temperature, specific conductance, and lead (Method of Standard Additions, EPA-600/4-79-020, Revised March 1983, Metals, Atomic Absorption Method, ¶8.5).

The four base wells should be resampled and analyzed for purgeable halocarbons (USEPA Method 601), purgeable aromatics (USEPA Method 602), and chloride.

C. SITES REQUIRING REMEDIAL ACTIONS (CATEGORY 3)

Immediate action should be planned for the oil pit. This pit appears to be an unlined containment structure and, therefore, is an obvious and ongoing source of ground water and soil pollution on this base. A remedial action plan should be developed and closure initiated.

[buck86]

APPENDIX A

DEFINITIONS, NOMENCLATURE, AND UNITS OF MEASUREMENT

DEFINITIONS, NOMENCLATURE, AND UNITS OF MEASUREMENT

AFB	Air Force Base
alluvium	Unconsolidated sediments deposited during comparatively recent geologic time by a stream or other body of running water.
alluvial fan	Alluvial material deposited as a cone or fan at the base of a mountain slope.
aquifer	A geologic formation, group of formations, or part of a formation that is capable of yielding water to a well or spring.
aquiclude	A body of relatively impermeable rock that is capable of absorbing water slowly but functions as an upper or lower boundary of an aquifer and does not transmit ground water rapidly enough to supply a well or spring.
aquitard	A confining bed that retards but does not prevent the flow of water to or from an adjacent aquifer.
aromatic	Designating cyclic organic compounds characterized by a high degree of stability in spite of their apparent unsaturated bonds and best exemplified by benzene and related structures, but also evident in other compounds.
artesian	Ground water confined under hydrostatic pressure.
as N	As weight of nitrogen
AVGAS	Aviation gasoline
cm/sec	Centimeter(s) per second
cone of depression	A depression in the potentiometric surface of a body of water that has the shape of an inverted cone and develops around a well from which water is being withdrawn.
conglomerate	The consolidated equivalent of gravel, both in size range and in the essential roundness and sorting of its constituent particles.
Cretaceous	A period of geologic time thought to have covered the span between 144 and 66.4 million years ago. Also, the corresponding system of rocks.
DDT	Dichlorodiphenyltrichloroethane, an insecticide
DEQPPM	Defense Environmental Quality Program Policy Memorandum
DESEP	Civil Engineering/Environmental Planning

DOD	Department of Defense
downgradient	In the direction of decreasing hydraulic static head; the direction in which ground water flows.
effluent	A liquid waste discharge from a manufacturing or treatment process, in its natural state, or partially or completely treated, that discharges into the environment.
°F	Degrees Fahrenheit
ft	Foot, feet
gpd/ft	Gallon(s) per day per foot
gpm	Gallon(s) per minute
HNU	A type of photoionization detector for measurement of organic vapors
hydraulic gradient	In an aquifer, the rate of change of pressure head per unit of distance of flow at a given point and in a given direction.
in.	Inch, inches
IRP	Installation Restoration Program
Jurassic	A period of geologic time thought to have covered the span between 2098 and 144 million years ago. Also, the corresponding system of rocks.
LEL	Lower explosive limit
matrix effect	The effect caused by the presence of certain constituents (such as chlorides and sulfides when analyzing for lead, or chlorides when analyzing for TOX), that interfere with atomic absorption spectrophotometry analyses. These interferences may result in less than the actual value of the contaminant being detected during analysis.
mg/g	Milligram(s) per gram
mg/L	Milligram(s) per liter
ml	Milliliter(s)
μg/g	Microgram(s) per gram
μg/L	Microgram(s) per liter
MOGAS	Motor gasoline

monitor well	A well used to measure ground water levels and to obtain samples.
msl	Mean sea level
No.	Number
NPDES	National Pollutant Discharge Elimination System
OEHL	Occupational and Environmental Health Laboratory
OEHL/TS	Occupational and Environmental Health Laboratory/Technical Services
pH	Negative logarithm of hydrogen ion concentration; measurement of acids and bases.
PCB	Polychlorinated biphenyl; highly toxic to aquatic life; PCBs persist in the environment for long periods of time and are biologically accumulative.
PCBs	Polychlorinated biphenyls
PDWS	Primary drinking water standard(s)
percolation	Movement of moisture by gravity or hydrostatic pressure through interstices of unsaturated rock or soil.
permeability	The property or capacity of a porous rock, sediment, or soil for transmitting a fluid without impairment of the structure of the medium; it is a measure of the relative ease of fluid flow under unequal pressure.
phenolics	Any of various acidic compounds analogous to phenol and regarded as hydroxyl derivatives of aromatic hydrocarbons.
piezometer	A well commonly used for instrumentation monitoring of low permeability materials.
Pleistocene	An epoch of geologic time thought to have covered the span between 1.6 million and 10,000 years ago.
POL	Petroleum, oil and lubricants
porosity	The property of a rock, soil, or other material of containing interstices.
potentiometric surface	An imaginary surface representing the static head of ground water and defined by the level to which water will rise in a well.
ppb	Part(s) per billion
ppm	Part(s) per million

PVC	Polyvinyl chloride
QC	Quality control
RCRA	Resource Conservation and Recovery Act
Recent	An epoch of geologic time thought to have covered the last 10,000 years.
specific capacity	The rate of discharge of a water well per unit of drawdown, commonly expressed as gallons per minute per foot.
specific conductivity	With reference to the movement of water in soil, a factor expressing the volume of transported water per unit of time in a given area.
STP	Sewage treatment plant
TCE	Trichloroethylene
TDS	Total dissolved solids
Tertiary	The first period of the Cenozoic era, thought to have covered the span of time between 66 and 3 to 2 million years ago.
TOC	Total organic carbon
TOX	Total organic halogens
transmissivity	The rate at which water is transmitted through a unit width under a unit hydraulic gradient.
USAF	United States Air Force
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
wash	A term applied in the western United States to the broad, shallow, gravelly or stony, normally dry bed of an intermittent stream, often situated at the bottom of a canyon; it is occasionally filled by a torrent of water.
water table	That surface of a body of unconfined ground water at which the pressure is equal to that of the atmosphere.

APPENDIX B

SCOPE OF WORK

6024

55X 55X

ORDER FOR SUPPLIES OR SERVICES

1. PAGE 1 OF

2. PROC INSTRUMENT ID NO. (PIIN)	3. CALL/ORDER NO.	4. DATE OF ORDER*	5. REQUISITION/PURCHASE REQUEST PROJECT NO.	6. CERTIFIED FOR NATIONAL DEFENSE UNDER
F33615-83-D-4002	0024	84AUG22	FY7624-84-01078	DO-C9

Mark all packages & papers with this number.

DOC REG 2/DMS REG 1 RATING

7. ISSUED BY CODE FQ8419

DEPARTMENT OF THE AIR FORCE
AIR FORCE SYSTEMS COMMAND
AERONAUTICAL SYSTEMS DIV/PMRSC
WRIGHT-PATTERSON AFB, OH 45433
BUYER: DIANA SUCHECKI
PHONE: (513) 255-5633

8. ADMINISTERED BY CODE S1403A

DCASMA CHICAGO
O'HARE INTERNATIONAL AIRPORT
P. O. BOX 66911
CHICAGO, IL 60666

DAMES & MOORE
AUG 29 1984
Park Ridge, Illinois

9. CONTRACTOR NAME AND ADDRESS CODE 1S346 FACILITY CODE IF "9" FOR MULTIPLE FACILITIES SEE SECT "G"

DAMES & MOORE
1550 NORTHWEST HIGHWAY
PARK RIDGE, IL 60068

(COOK COUNTY)
PHONE: (312) 297-6120

MAILING DATE
AUG 24 1984
DUPLICATE ORIGINAL

10. MAIL INVOICES TO

11. DISCOUNT FOR PROMPT PAYMENT

1ST N % DAYS NET DAYS
2ND % DAYS OTHER IF "9" SEE SECT "B"
3RD % DAYS

12A. PURCHASE OFFICE POINT OF CONTACT

LPV/L58/LPV

12B. RESERVED FOR SERVICE/AGENCY USE

13. PAYMENT WILL BE MADE BY CODE S1402A IF "9" SEE SECT "G"

DCASR CHICAGO
O'HARE INTERNATIONAL AIRPORT
P. O. BOX 66475
CHICAGO, IL 60666

14. TYPE CONTRACTOR: A
15. SECURITY A. CLAS: U B. DATE OF DD 254

16. CONTRACT ADMINISTRATION DATA

A. FAST PAY	B. CONTRACT (1) KIND	(2) TYPE	C. ABSTRACT RECIP ADP POINT	D. SPL CONT PROVISIONS	E. CONT ADMIN FUNC LMT	17. (RESERVED)	18. SVC/AGENCY USE	19. SURV CRIT	20. TOTAL AMOUNT
	0	9						C	NOT TO EXCEED $ 54,186.87

21. APPROPRIATION AND ACCOUNTING DATA

A. SCTY CLS	B. ACRN	C. APPROPRIATION	D. LIMIT SUBHEAD	E. SUPPLEMENTAL ACCOUNTING CLASSIFICATION
U	AA	9740810.200		E74 4308 P820 503701

F. CPN RECIPIENT DODAAD G. OBLIGATION AMOUNT 54,186.87 H. NON-CLIN/ELIN PAYMENT PROV I. SVC AGENCY USE FY7624-84-01078*

22. TYPE OF ORDER

DELIVERY X B. NON-DOD CONTRACT NO. This delivery order is subject to instructions contained on this side of form only and is issued in accordance with and subject to terms and conditions of above numbered contract, or Non-DOD Contract No.

PURCHASE Reference your CONTRACT CATEGORY CODE: FAZ

Furnish the following on terms specified herein including, for U.S. purchases, General Provisions of Purchase Order on DD form 1155 (EXCEPT CLAUSE NO 13 APPLIES ONLY IF THIS BOX IS CHECKED, AND NO 15 IF THIS BOX IS CHECKED), special provisions and delivery as indicated. This purchase is negotiated under authority of 10 USC 2304(a)( ) or as specified in the schedule if within the U.S., its possessions or Puerto Rico; if otherwise, under 2304(a)(6).

If checked, Additional General Provisions apply; supplies shall sign Acceptance on DD form 1155 and return copies.

*If quantity accepted by the Government is same as quantity ordered, indicated by ✓ mark. If different enter actual quantity accepted below quantity ordered and encircle.

23. UNITED STATES OF AMERICA
Christopher D. Miller 84AUG06
CHRISTOPHER D. MILLER (YYMMMDD)
BY: NAME OF CONTRACTING/ORDERING OFFICER AND DATE

24. TOTAL
28. DIFFERENCES

25. QUANTITY ORDERED HAS BEEN
INSPECTED RECEIVED ACCEPTED, AND CONFORMS TO THE CONTRACT EXCEPT AS STATED

26. SHIP NO. PARTIAL FINAL
27. D.O. VOUCHER NO.
23 INITIALS

DATE SIGNATURE OF AUTHORIZED GOVERNMENT REPRESENTATIVE
31. PAID BY
32. Amount Verified Correct For
30. PAYMENT COMPLETE PARTIAL FINAL
33. CHECK NUMBER
35. CERTIFY THIS AMOUNT IS CORRECT AND PROPER FOR PAYMENT
SIGNATURE AND TITLE OF CERTIFYING OFFICER
34. BILL OF LADING NO.

36. RECEIVED AT	37. RECEIVED BY	38. DATE RECEIVED	39. TOTAL CONTAINERS	40. S/R ACCOUNT NUMBER	41. S/R VOUCHER NO.

PREVIOUS EDITION IS OBSOLETE.

AFSC FORM AUG 80 700

*When used as a formal contract this will be the effective date.

*1947 HSG/FMC PENTAGON, AF FORM 402, 4E7-0884-3 CH1 0 MAR 84

70E 70E

PART I SECTION B OF THE SCHEDULE
SUPPLIES LINE ITEM DATA

1. PROC INSTRUMENT ID NO. (PIIN): F33615-83-D-4002
2. SPIIN: 0024
3. PAGE 2 OF

4. ITEM NO. 0001 | 5. QUANTITY* 1 | 6. PURCH UNIT LO | 7. UNIT PRICE $ | 8. TOTAL ITEM AMOUNT* $ E27,183.10

9. SCTY CLAS U | 10. ACRN AA | 11. NSN N | 12. FSCM AND PART NUMBER | 13. CIRR

14. SITE CODES A.POA D B.ACP D C.FOB D | 15. NOUN IRP PHASE II FIELD EVALUATION OF BUCKLEY ANG CO & DATA | 16. SVC/AGENCY USE

17. PR/MIPR DATA FY7624-84-01078-0001 | 18. AUTHORIZED RATE A.PROGRESS PAY % B.RECOUP % | 19. CONTRACT PERCENT FEE % | 20. SVC ID NO. | 21. ITEM/PROJ MGR FY7624

22. 1ST DISCOUNT A. % B.DAYS | 23. 2ND DISCOUNT A. % B.DAYS | 24. 3RD DISCOUNT A. % B.DAYS | 25. NET DAYS | 26. QUANTITY VARIANCE A. OVER % B. UNDER % | 27. TYPE CONTRACT Y | 28. OPR

29. DESCRIPTIVE DATA

ACCOMPLISH FIELD EVALUATION OF BUCKLEY ANG CO & DATA FOR IRP PHASE II IN ACCORDANCE WITH DESCRIPTION OF TASK SET FORTH IN PARA. I, PAGES 4 -11 OF THIS ORDER WHICH CAN BE PERFORMED THROUGH THE EXPENDITURE OF THE FOLLOWING LABOR HOURS:

CATEGORY	HOURS
SENIOR LEVEL PROFESSIONAL	148
MID LEVEL PROFESSIONAL	221
TECHNICIAN	198
SUPPORT	145

IN NO EVENT SHALL THE AMOUNT PAID FOR THE NUMBER OF HOURS SPECIFIED EXCEED THE AMOUNT SPECIFIED IN BLOCK 8 ABOVE. FURNISH DATA IN ACCORDANCE WITH ATCH 1, DD FORM 1423, OF THE BASIC CONTRACT, AS IMPLEMENTED BY PARA. VI, PAGE 9 HEREOF.

4. ITEM NO. 0002 | 5. QUANTITY* 1 | 6. PURCH UNIT LO | 7. UNIT PRICE $ | 8. TOTAL ITEM AMOUNT* $ E26,021.21

9. SCTY CLAS U | 10. ACRN AA | 11. NSN N | 12. FSCM AND PART NUMBER | 13. CIRR

14. SITE CODES A.POA D B.ACP D C.FOB D | 15. NOUN SUPPORT | 16. SVC/AGENCY USE

17. PR/MIPR DATA FY7624-84-01078-0002 | 18. AUTHORIZED RATE A.PROGRESS PAY % B.RECOUP % | 19. CONTRACT PERCENT FEE % | 20. SVC ID NO. | 21. ITEM/PROJ MGR FY7624

22. 1ST DISCOUNT A. % B.DAYS | 23. 2ND DISCOUNT A. % B.DAYS | 24. 3RD DISCOUNT A. % B.DAYS | 25. NET DAYS | 26. QUANTITY VARIANCE A. OVER % B. UNDER % | 27. TYPE CONTRACT Y | 28. OPR

29. DESCRIPTIVE DATA

SUPPORT OF ITEM 0001.

THE AMOUNT SPECIFIED IN BLOCK 8 ABOVE IS THE MAXIMUM AMOUNT WHICH MAY BE PAID FOR THIS ITEM.

*REPRESENTS NET AMOUNT OF INCREASE/DECREASE WHEN MODIFYING EXISTING ITEM NO.

N = NOT APPLICABLE
U = UNDEFINITIZED
NSP = NOT SEPARATELY PRICED
E = ESTIMATED
- (IN QTY AND $) = DECREASE
+ OR - (IN ITEM NO.) = ADDITION OR DELETION
CIRR: CONTROLLED ITEM ...
SITE: S = SOURCE, D = DESTINATION

PART I SECTION B OF THE SCHEDULE SUPPLIES LINE ITEM DATA	1. PROC INSTRUMENT ID NO. (PIIN)	2. SPIIN	3.
	F33615-83-D-4002	0024	PAGE 3 OF

4. ITEM NO. 0004 | 5. QUANTITY* 1 | 6. PURCH UNIT LO | 7. UNIT PRICE $ | 8. TOTAL ITEM AMOUNT* $ E982.56

9. SCTY CLAS U | 10. ACRN AA | 11. NSN N | 12. FSCM AND PART NUMBER | 13. CIRR

14. SITE CODES A.PQA D B.ACP D C.FOB D | 15. NOUN CHEM/PHYS ANALYSIS AND DATA | 16. SVC/AGENCY USE

17. PR/MIPR DATA FY7624-84-01078-0004 | 18. AUTHORIZED RATE A.PROGRESS PAY % B.RECOUP % | 19. CONTRACT PERCENT FEE % | 20. SVC ID NO. | 21. ITEM/PROJ MGR FY7624

22. 1ST DISCOUNT A. % B.DAYS | 23. 2ND DISCOUNT A. % B.DAYS | 24. 3RD DISCOUNT A. % B.DAYS | 25. NET DAYS | 26. QUANTITY VARIANCE A. OVER % B. UNDER % | 27. TYPE CONTRACT J | 28. OPR

29. DESCRIPTIVE DATA

PERFORM CHEMICAL TESTS IN ACCORDANCE WITH DESCRIPTION OF TASK SET FORTH IN PARAGRAPH 1, PAGES 4-11 OF THIS ORDER AND DELIVER DATA IN ACCORDANCE WITH ATTACHMENT #3, DD FORM 1423, CONTRACT DATA REQUIREMENTS LIST OF THE BASIC CONTRACT, AS IMPLEMENTED BY PARAGRAPH VI, PAGE 9 HEREOF.

THE AMOUNT SPECIFIED IN BLOCK 8 ABOVE IS THE MAXIMUM AMOUNT WHICH MAY BE PAID FOR THIS ITEM.

4. ITEM NO. | 5. QUANTITY* | 6. PURCH UNIT | 7. UNIT PRICE $ | 8. TOTAL ITEM AMOUNT* $

9. SCTY CLAS | 10. ACRN | 11. NSN | 12. FSCM AND PART NUMBER | 13. CIRR

14. SITE CODES A.PQA B.ACP C.FOB | 15. NOUN | 16. SVC/AGENCY USE

17. PR/MIPR DATA | 18. AUTHORIZED RATE A.PROGRESS PAY % B.RECOUP | 19. CONTRACT PERCENT FEE % | 20. SVC ID NO. | 21. ITEM/PROJ MGR

22. 1ST DISCOUNT A. % B.DAYS | 23. 2ND DISCOUNT A. % B.DAYS | 24. 3RD DISCOUNT A. % B.DAYS | 25. NET DAYS | 26. QUANTITY VARIANCE A. OVER % B. UNDER % | 27. TYPE CONTRACT | 28. OPR

29. DESCRIPTIVE DATA

*REPRESENTS NET AMOUNT OF INCREASE/DECREASE WHEN MODIFYING EXISTING ITEM NO

N = NOT APPLICABLE
U = UNDEFINITIZED
NSP = NOT SEPARATELY PRICED

E = ESTIMATED
- (IN QTY AND $) = DECREASE
+ OR - (IN ITEM NO) = ADDITION OR DELETION
CIRR: CONTROLLED ITEM RPT RQMT

SITE CODES: S = SOURCE, D = DESTINATION, O = INTERMEDIATE

u

5 JUL 1984

Installation Restoration Program
Phase II Field Evaluation
Buckley Air National Guard Base CO

I. Description of Work

The purpose of this task is to determine if environmental contamination has resulted from waste disposal practices, fuel spills and fire training activities at Buckley ANGB CO; to provide estimates of the magnitude and extent of contamination, should contamination be found; to identify potential environmental consequences of migrating pollutants; to identify any additional investigations and their attendant costs necessary to properly evaluate the magnitude, extent, and direction of movement of discovered contaminants.

Ambient air monitoring of hazardous and/or toxic material for the protection of contractor and Air Force personnel shall be accomplished when necessary, especially during the drilling operation.

The presurvey report (mailed under seperate cover) and Phase I IRP report (mailed under seperate cover) incorporated background and description of the sites for this task. To accomplish the survey effort, the contractor shall take the following steps.

A. General

1. Determine the aerial extent of each site by reviewing available aerial photos of the base, both historical and the most recent panchromatic and infrared, and by field reconnaissance.

2. Locations where surface water, sediment, and core samples are collected shall be marked with a permanent marker, and the location recorded on a site map.

3. A total of four ground-water monitoring wells shall be installed. The exact location of the wells shall be determined in the field.

4. Each ground-water monitoring well shall be constructed of 2-inch I.D. Schedule 40 PVC casing and screen. Each well shall be completed to a depth of at least 20 feet below the water table surface. The screened interval in each well shall consist of 0.010 inch slotted PVC screen depending upon geologic findings during the drilling operation. The screened interval shall penetrate the water table by 20 feet and extend 5 feet above the water table. A gravel pack or sand pack, as determined in the field as suitable for the soil formation, shall be emplaced around the well screen. Clean, fine grained sand shall be placed above the gravel pack. Bentonite pellets shall be placed on top of the sand to seal the screened interval, and the seal shall be completed using a bentonite grout mixture to the surface. Each well shall be provided with a surface grout seal and protective steel casing with locking cap. All wells shall be developed, water levels measured, and the locations surveyed and recorded on a site map.

5. Ground-water monitoring wells shall comply with U.S. EPA publication 330/9-81-002 NEIC Manual for Groundwater/Subsurface Investigation at Hazardous Waste Sites, and State of Colorado requirements for monitoring well installation. All wells shall be developed until they produce clear, sand-free water. Only screw type joints shall be used. Glue fittings are not permitted.

6. All water samples shall be analyzed on site by the contractor for pH, temperature, and specific conductance. Sampling, maximum holding time, and preservation of samples shall comply strictly with the following references: Standard Methods for the Examination of Water and Wastewater, 15th Ed. (1980), pp 35-42; ASTM, Part 31, pp 72-82, (1976), Method D-3370; and Methods for Chemical Analysis of Waters and Wastes, EPA Manual 600/4-79-020, pp xiii to xix (1979). All water samples shall be analyzed using minimum detection levels, as specified in Attachment 1.

7. The contractor shall split all water samples. One set of samples shall be analyzed by the contractor and the other set of samples shall be forwarded for analysis through overnight delivery to:

USAF OEHL/SA
Bldg 140
Brooks AFB TX 78235

The samples sent to the USAF OEHL/SA shall be accompanied by the following information:

a. Purpose of sample (analyte)

b. Installation name (base)

c. Sample number (on containers)

d. Source/location of sample

e. Contract Task Numbers and Title of Project

f. Method of collection (bailer, suction pump, air-lift pump, etc.)

g. Volumes removed before sample taken

h. Special Conditions (use of surrogate standard, special nonstandard preservations, etc.)

i. Preservatives used

This information shall be forwarded with each sample by properly completing an AF Form 2752 (copy of form and instruction on proper completion mailed under separate cover). In addition, copies of field logs documenting sample collection should accompany the samples. Chain-of-custody records for all samples, field blanks, and quality control duplicates shall be maintained.

All contractor QA/QC program analysis results shall be included in the analytical results of draft final report (as specified in Item VI below).

8. Field data collected for each site shall be plotted and mapped. The nature of contamination and the magnitude and potential for contaminant flow within each site to receiving streams and ground waters shall be determined or estimated. Upon completion of the sampling and analysis, the data shall be tabulated in the next R&D Status report, as specified in Item VI below.

B. In addition to items delineated in A above, conduct the following specific actions at sites identified on Buckley ANGB CO:

1. Site 1. Landfill Zone including Oil Pit

a. Install four ground-water monitoring wells, two wells located downgradient of the site and two wells located upgradient of the site. Total footage of wells drilled shall not exceed 220 feet.

b. One downgradient well shall be located 50 feet north of the landfill along the west boundary of the installation. The second downgradient well shall be located 50 feet west of the oil pit, in a position so as not to interfere with the north-south gravel road. Wells shall be an average of 40 feet in depth. Soil samples shall be retained for analysis at 2 1/2-foot intervals from the surface to 10 feet below the surface (BLS). From 10-40 feet BLS, samples shall be retained for analysis at 15.0 feet BLS, 5 feet above the water table, at the saturated/unsaturated zone interface, and 5 feet below the water table. A maximum of 6 samples shall be analyzed.

c. Each soil sample shall be analyzed for Total Organic Carbons (TOC), Total Organic Halogens (TOX), phenols, and the pesticides specified in Attachment 1.

d. Collect one ground-water sample from each downgradient monitoring well.

e. Each ground-water sample shall be analyzed for TOC, TOX, phenols, Total Dissolved Solids (TDS), cadmium, chromium, lead, nickel, and silver, and the pesticides specified in Attachment 1.

f. One upgradient well shall be located 400 feet north of the southern base boundary. The second upgradient well shall be located 400 feet east of the western base boundary. Wells shall be an average of 70 feet in depth. Soil samples shall be retained for analysis at 5 feet above the water table, at the saturated/unsaturated zone interface, and 5 feet below the water table. A maximum of 6 samples shall be analyzed.

g. Each soil sample shall be analyzed for TOC, TOX, phenols, and the pesticides specified in Attachment 1.

h. Collect one ground-water sample from each upgradient well.

i. Each ground-water sample shall be analyzed for TOC, TOX, phenols, TDS, cadmium, chromium, lead, nickel, and silver, and the pesticides specified in Attachment 1.

2. Site 2. Fire Training Area 2

a. Two soil borings shall be drilled at this site. Each boring shall be drilled to a depth of 10 feet BLS. One boring shall be centrally located at the site. The second boring shall be located downhill, 100 feet to the northeast of the site. Soil samples shall be collected with a split spoon sampler. Samples shall be retained for analysis at 2 1/2-foot intervals from the surface to 10 feet BLS. A maximum of four samples shall be analyzed.

b. Each soil sample shall be analyzed for TOC, TOX, phenols, and lead.

3. Site 3. Fire Training Area 3

a. Two soil borings shall be drilled at this site. Each boring shall be drilled to a depth of 10 feet BLS. One boring shall be centrally located at the site. The second boring shall be located downhill, 100 feet to the southwest of the site. Soil samples shall be collected with a split spoon sampler. A maximum of four samples shall be analyzed.

b. Each soil sample shall be analyzed for TOC, TOX, phenols, and lead.

4. Site 4. Fire Training Area 1

a. Two soil borings shall be drilled at this site. Each boring shall be drilled to depth of 10 feet BLS. One boring shall be centrally located at the site. The second boring shall be located 100 feet northeast of the site toward the abandoned reservoir. Soil samples shall be collected with a split spoon sampler. Samples shall be retained for analysis at 2 1/2 foot intervals from the surface to 10 feet BLS. A maximum of four samples shall be analyzed.

b. Each soil sample shall be analyzed for TOC, TOX, phenols, and lead.

5. Site 5. Storm Drainage System Near Building 801

a. Three soil borings shall be drilled at this site. Each boring shall be drilled to a depth of 10 feet BLS. One boring shall be located in the ditch (tributary) immediately north and downgradient of Building 801. The second boring shall be located south of building 801 in the ditch (tributary) that receives runoff from the apron. The third boring shall be located in the ditch that is formed by the merging of the two aforementioned tributaries, approximately 700 feet south of the second boring. Soil samples shall be collected with a split spoon sampler. Samples shall be retained for analysis at 2 1/2-foot intervals from the surface to 10 feet BLS. A maximum of 6 samples shall be analyzed.

b. Each soil sample shall be analyzed for TOC, TOX, phenols, and lead.

c. Well Installation and Clean-up

The well and boring area shall be cleaned following the completion of each well and boring. Drill cuttings shall be removed and the general area clean. If hazardous waste is generated in the process of well installation the contractor shall be responsible for proper containerization for eventual government disposal. The contractor shall determine those drill cuttings suspected as being hazardous waste based upon discoloration, odor, or organic vapor detection instrument. The contractor shall test 2 samples of the suspected hazardous waste for EP Toxicity and Ignitability as specified in Attachment 1. Disposal of drill cuttings are not the responsibility of the [illegible].

d. Results of all sampling and analysis shall be tabulated and incorporated in the Informal Technical Information report (Sequence 3 Atch 1 and Sequence 2 Atch 3 as specified in Item VI below) and forwarded to USAF [illegible] for review.

e. Reporting

1. A draft report delineating all findings of this field investigation shall be prepared and forwarded to the USAF OEHL, as specified in Item VI below, for Air Force review and comment. This report shall include a [illegible] of the regional site specific hydrogeology, well and boring logs, data from water level surveys, water quality and soil analysis results, [illegible] geohydrologic cross sections, groundwater and gradient vector maps, [illegible] laboratory quality assurance information. The report shall follow the [illegible] OEHL format (mailed under separate cover).

2. The recommendation section will address each site and [illegible] them by categories. Category I will consist of sites where no further action, including remedial action, is required. Data for these sites are [illegible] sufficient to rule out unacceptable health or environmental risks. [illegible] II sites are those requiring additional monitoring or work to quan[illegible] further assess the extent of current or future contamination. Category [illegible] sites that will require remedial actions (ready for IRP Phase IV [illegible]). In each case the contractor will summarize or present the results of [illegible] environmental or regulatory criteria, or other pertinent informa[illegible] these conclusions.

F. Cost Estimates

The contractor shall provide cost estimates for all additional [illegible] recommended to permit proper determination of contaminants. The recommen[illegible] provided shall include all efforts required to determine the magnitude [illegible] of movement of discovered contaminants along with an estimate of [illegible] required to accomplish the proposed effort. This information shall be [illegible] in a separately bound appendix to the final report.

[illegible]

III. Base Support: None

IV. Government Furnished Property: None

V. Government Points of Contact:

1. 1Lt Maria R. LaMagna
USAF OEHL/TS
Brooks AFB TX 78235
(512) 536-2158
AV 240-2158

2. Mr Michael Rowan
140 TAC Hospital/SGPB
Buckley ANGB CO 80010
(303) 340-9675
AV 877-9672

3. Maj Edward M. Cain
OLAA/DE
Buckley ANGB CO 80010
(303) 340-9900
AV 877-9900

4. Lt Col Michael C. Washeleski
ANGSC/SGB
Andrews AFB MD 20331
(301) 981-5926
AV 858-5926

VI. In addition to sequence numbers 1, 5 and 10 which are applicable to all orders, the reference numbers below are applicable to this order. Also shown are data applicable to this order:

Sequence No	Block 10	Block 11	Block 12	Block 13	Block 14
Atch 1					
4	ONE/R	84DEC30	85JAN10	85MAY10	*
3	O/Time	**	**		2
Atch 3					
2	O/Time	**	**		2

*[illegible] mum of two draft reports will be required. After incorporating Air Force comments concerning the first draft report, the contractor shall supply the USAF OEHL with a second draft report. The report will be forwarded to the applicable regulatory agencies for their comments. The contractor shall supply the USAF OEHL with 20 copies of each draft report and 50 copies plus the original camera ready copy of the final report.

**Upon completion

F33615-83-D-4002/0024

Levels of Detection Required

Levels of Detection are for water unless shown otherwise:

Analyte	Analytical Method	Detection Limit
*Total Organic Carbons (TOC)	EPA Method 415.1	1000 µg/L
*Total Organic Halogens (TOX)	EPA Method 9020	5 µg/L (water); 5 µg/g (soil)
Phenol	EPA Method 420.1	1 µg/L (water); 1 µg/g (soil)
Cadmium (1)	EPA Method 213.2	10 µg/L
Chromium (1)	EPA Method 218.1	50 µg/L (water); 5 µg/g (soil)
Lead (1)	EPA Method 239.2	20 µg/L (water); 2 µg/g (soil)
Nickel	EPA Method 249.1	100 µg/L
Silver (1)	EPA Method 272.2	10 µg/L
Total Dissolved Solids (TDS) (2)	EPA Method 160.1	1000 µg/L
EP Toxicity	40 CFR 261.24	**
Ignitability	40 CFR 261.21	***
Aldrin	Standard 509A	.02 µg/L
DDT isomers	Standard 509A	.02 µg/L
Dieldrin	Standard 509A	.02 µg/L
Endrin (1)	Standard 509A	.02 µg/L
Heptachlor	Standard 509A	.02 µg/L
Heptachlor Epoxide	Standard 509A	.02 µg/L
Methoxychlor (1)	Standard 509A	.20 µg/L
2,4-D (1)	Standard 509B	.06 µg/L
2,4,5-T	Standard 509B	.06 µg/L
2,4,5-TP (Silvex) (1)	Standard 509B	.06 µg/L

For soils, use detection levels shown above, but report values as micrograms pesticide per gram of soil.

(1)=Primary Drinking Water Standard, 40 CFR 141.11.

(2)=Secondary Drinking Water Standard, 40 CFR 143.3.

*Detection levels for TOC and TOX must be 3 times the noise level of the instrument. Laboratory distilled water must show no response. If so, corrections of positive results must be made.

F33615-83-D-4002/0024

**Metal	µg/L of solution
As	10
Ba	200
Cd	10
Cr	50
Pb	20
Hg	1
Se	10
Ag	10

**Determine if sample is ignitable at 140°F or below. If so, it is considered a hazardous waste.

F33615-83-D-4002/0024

PART I SECTION F OF THE SCHEDULE
SUPPLIES SCHEDULE DATA

1. PROC INSTRUMENT ID NO. (PIIN): F33615-83-D-4002 | 2. SPIIN: 0024 | 3. PAGE 12 OF

4. ITEM NO.	5. ACRN	6. TSP PRI	7. MILSTRIP DOC NO. AND SUFFIX	8. CON ITEM SERIAL NO.	9. ENDING SERIAL NO. (WHEN APPL)	10. CLIN IDENT EXHIBIT
0001	AA					

	11. DEL SCHED DATE	12. ENDING DATE (WHEN APPL)	13. DEL SCHEDULE QTY*	14. SCTY CLAS	15. SHIP TO	16. MARK FOR
A.	85DEC30		1	U	FY7624	
B.						
C.						
D.						
E.						

17. DESCRIPTIVE DATA

SEE SECTION H (iv) OF THE BASIC CONTRACT FOR FY7624 ADDRESS.

ALL TECHNICAL EFFORT TO BE COMPLETED NO LATER THAN 84 DEC 30. DATE ABOVE IS DATE FOR GOVERNMENT ACCEPTANCE OF DATA.

DATA TO BE DELIVERED IN ACCORDANCE WITH ATTACHMENT #1, DD FORM 1423, AS IMPLEMENTED BY PARAGRAPH VI, PAGE 7 HEREOF.

4. ITEM NO.	5. ACRN	6. TSP PRI	7. MILSTRIP DOC NO. AND SUFFIX	8. CON ITEM SERIAL NO.	9. ENDING SERIAL NO. (WHEN APPL)	10. CLIN IDENT EXHIBIT
0002	AA					

	11. DEL SCHED DATE	12. ENDING DATE (WHEN APPL)	13. DEL SCHEDULE QTY*	14. SCTY CLAS	15. SHIP TO	16. MARK FOR
A.	84DEC30		1	U	FY7624	
B.						
C.						
D.						
E.						

17. DESCRIPTIVE DATA

SEE SECTION H (iv) OF BASIC CONTRACT FOR FY7624 ADDRESS.

ALL TECHNICAL EFFORT TO BE COMPLETED NO LATER THAN 84 DEC 30.

4. ITEM NO.	5. ACRN	6. TSP PRI	7. MILSTRIP DOC NO. AND SUFFIX	8. CON ITEM SERIAL NO.	9. ENDING SERIAL NO. (WHEN APPL)	10. CLIN IDENT EXHIBIT
0004	AA					

	11. DEL SCHED DATE	12. ENDING DATE (WHEN APPL)	13. DEL SCHEDULE QTY*	14. SCTY CLAS	15. SHIP TO	16. MARK FOR
A.	85DEC30		1	U	FY7624	
B.						
C.						
D.						
E.						

17. DESCRIPTIVE DATA

SEE SECTION H (iv) OF BASIC CONTRACT FOR FY7624 ADDRESS.

DATA TO BE DELIVERED IN ACCORDANCE WITH ATTACHMENT #3, DD FORM 1423, AS IMPLEMENTED BY PARAGRAPH VI, PAGE 9 HEREOF.

*REPRESENTS A NET INCREASE/DECREASE WHEN NO + OR − APPEARS AFTER THE ITEM NO
E = ESTIMATED
− (IN QTY) = DECREASE
+ OR − (IN ITEM NO) = ADDITION OR DELETION

APPENDIX C

WELL COMPLETION LOGS AND GEOLOGICAL DRILLING LOGS

BUCKLEY ANGB
BORING MW-1

10/23/84

Depth (ft)	Blows	Symbol	Description
0.0'		SM	Topsoil
0–5		SC	Yellow, low plasticity, medium to fine, sandy clay
5–7		ML	Bluish-gray, weathered silt/clay stone
7–10		SC	Yellow, sandy clay
10–11		SM	Bluish-gray, silt/clay stone
11–13		SC	Yellow, sandy clay
13–15			Light brown to yellow sand/silt stone with rust staining
15–18		SM	Bluish-gray, silt/clay stone
18–22	50+	SC	Yellow, brown and black, very weak, weathered sandstone; moist
22–25		CL	Brown, soft clay mixed with hard sandstone
25–30	35		Light gray silt stone with thin (1/16 inch), yellow sand lenses.
30–35	62		Gray, weak shale with black flecks
35–50			Blue, waxy, weak shale
			Grades to gray-blue, stronger, not as waxy

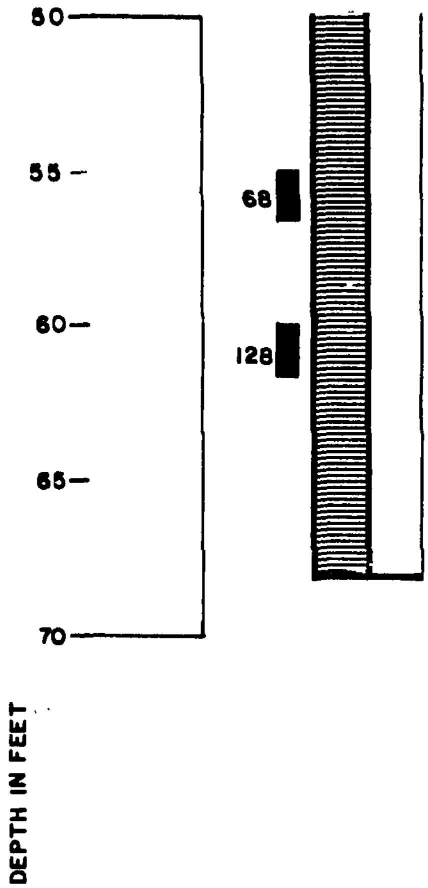
DEPTH IN FEET: 0, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50

LOG OF BORING

Dames & Moore

PLATE C-I

BUCKLEY ANGB
BORING MW-1



Gray-blue shale, heavily weathered in places, with thin sand and coal seams; moist

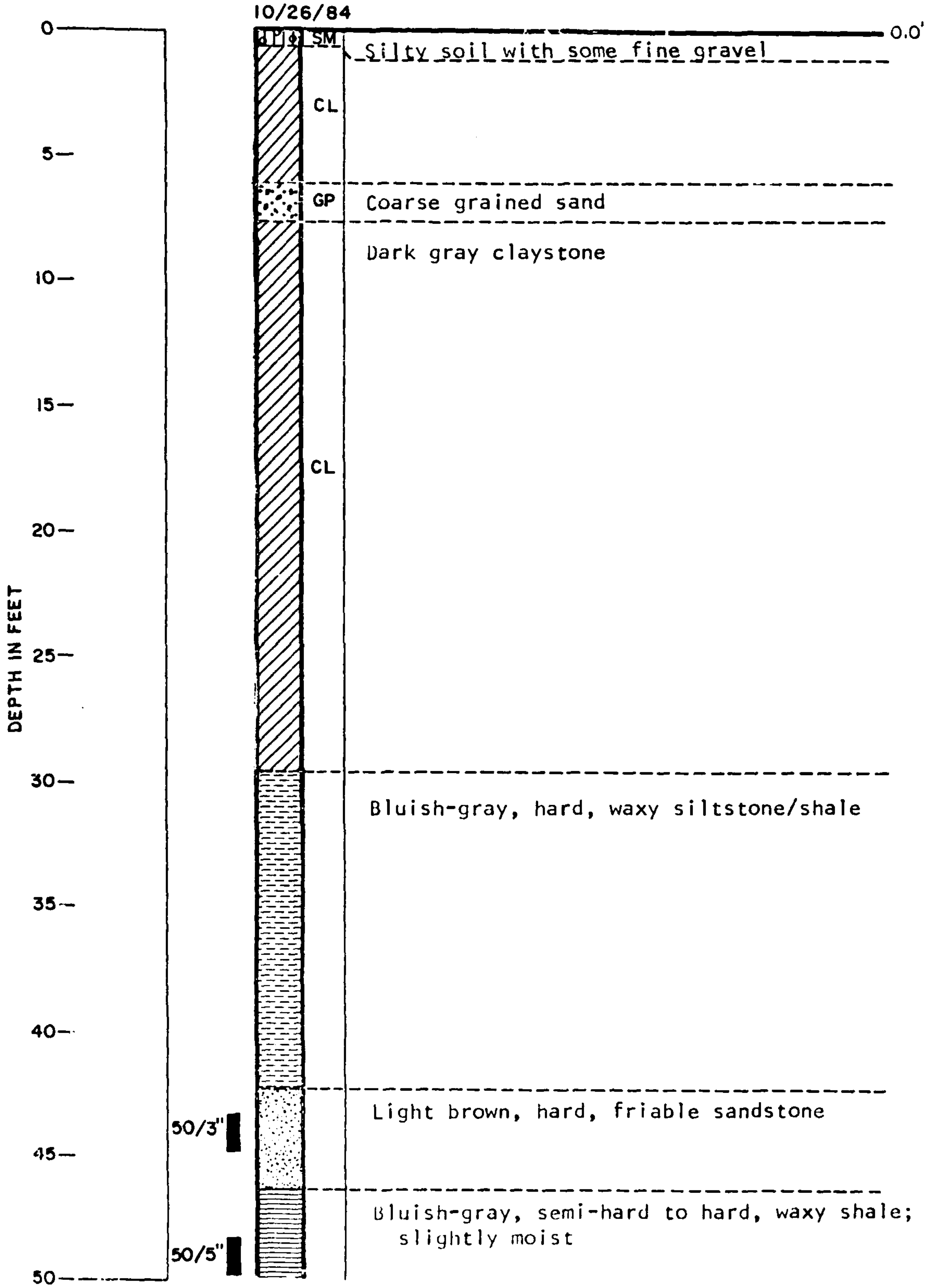
T.D. 68.5 Feet Very little moisture

LOG OF BORING

Dames & Moore

PLATE C-2

BUCKLEY ANGB
BORING MW-2

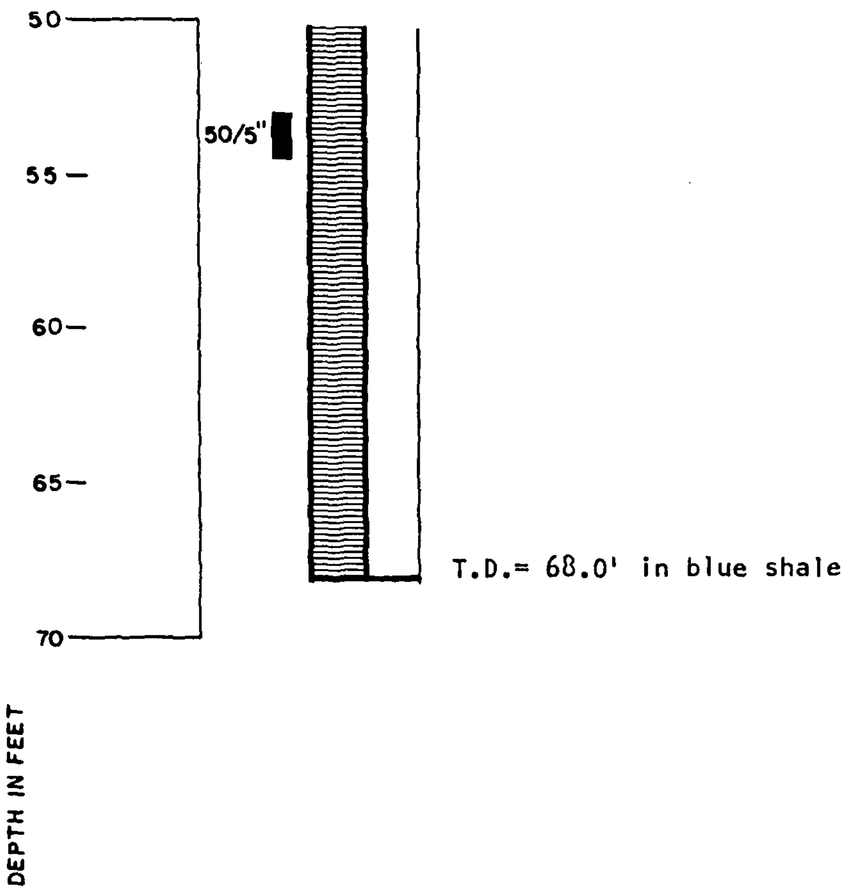


LOG OF BORING

Dames & Moore

PLATE C-3

BUCKLEY ANGB
BORING MW-2

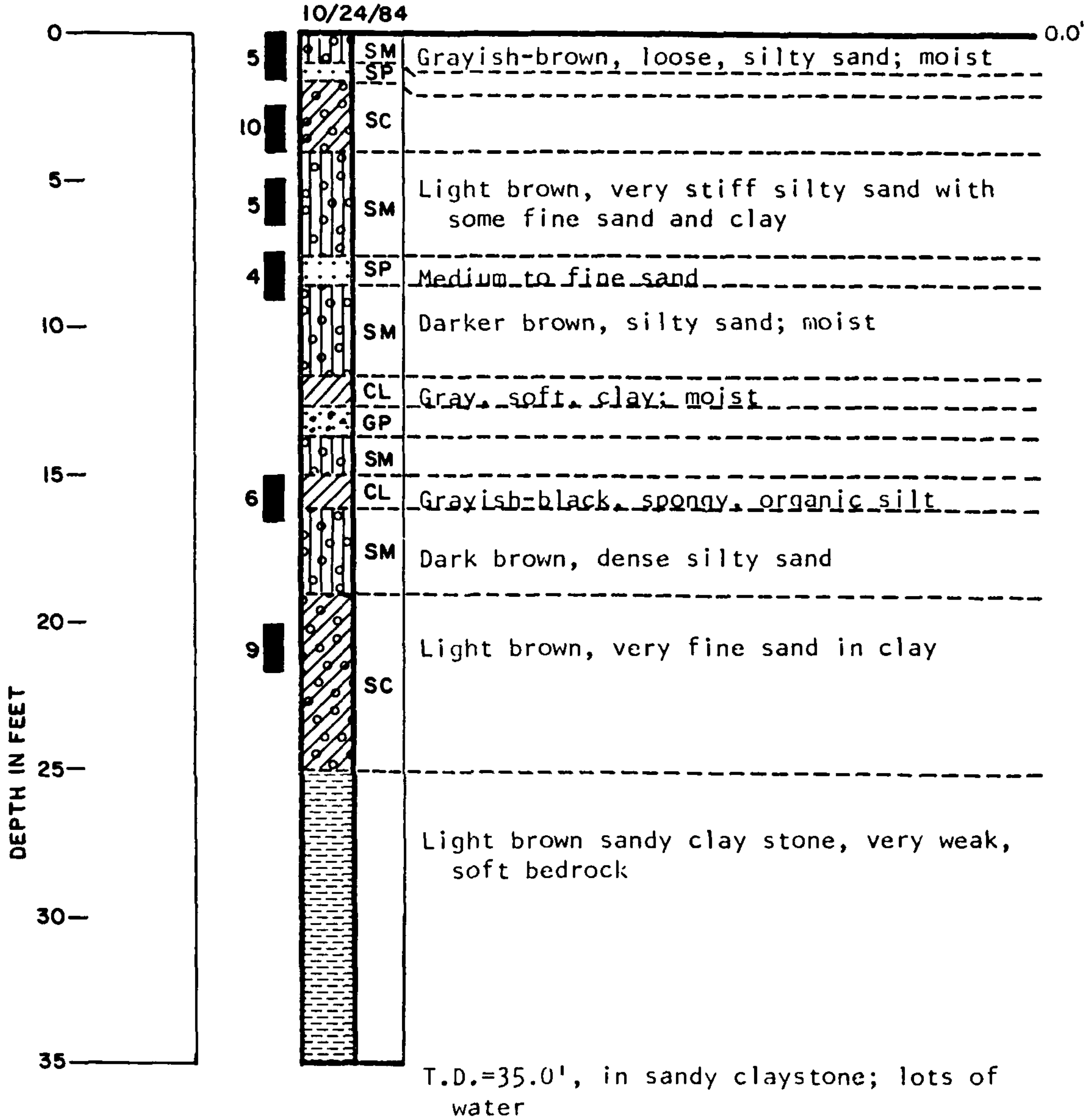


LOG OF BORING

Dames & Moore

PLATE C-4

BUCKLEY ANGB
BORING MW-3



LOG OF BORING

Dames & Moore

PLATE C-5

BUCKLEY ANGB
BORING MW-4

10/25/84 — 0.0'

DEPTH IN FEET (0–35)

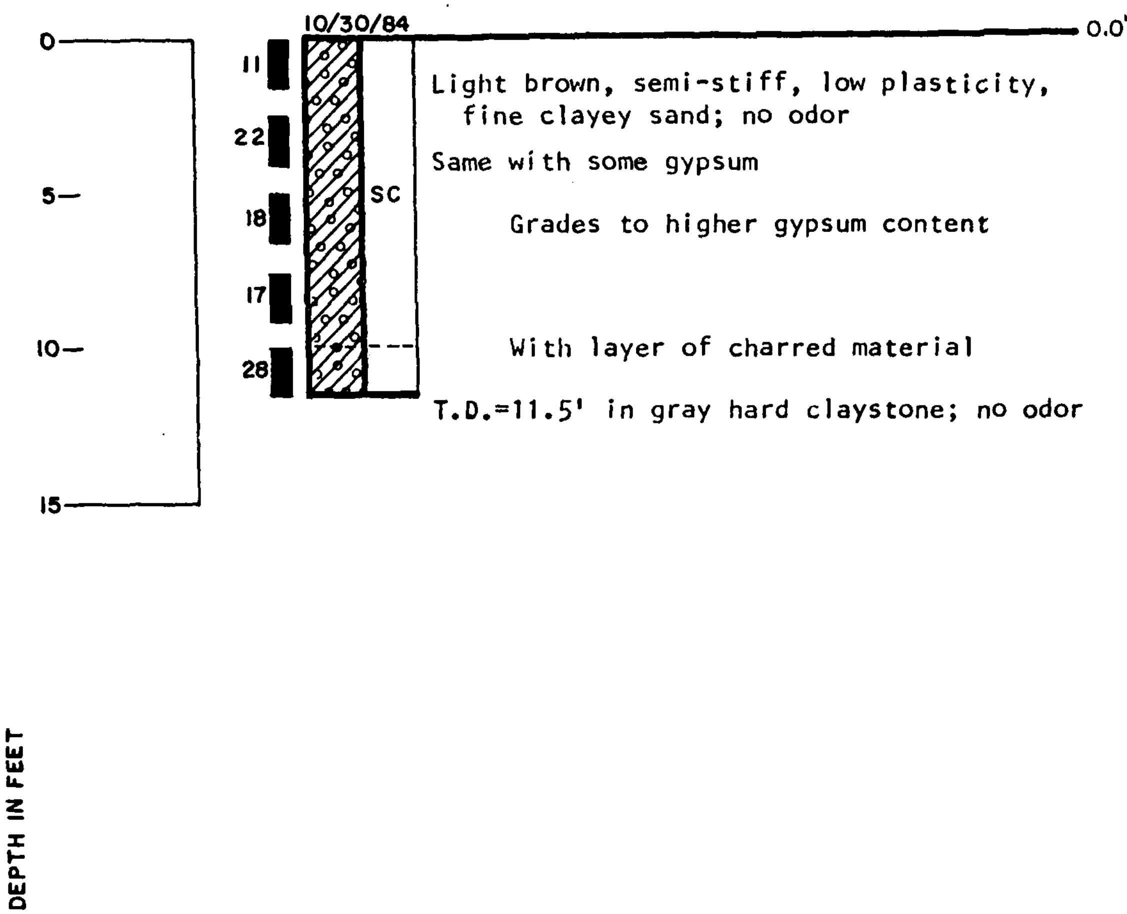
Blow count	Symbol	Description
5	ML	Black soil
8	SM	Dark brown, loose, fine sandy silt
7, 13	ML	Light brown, semi-hard silt with weak structure Rock flour with occasional gravel and some white streaks
	CL	Light brown, soft, plastic clay; moist
10	SM	Black, spongy organic silt
	CL	Brownish-gray clay with gypsum lenses
7	GP	Loose, poorly sorted, sand and gravel (up to 2 inches in diameter) Weak claystone Grading to firm claystone

LOG OF BORING

Dames & Moore

PLATE C-6

BUCKLEY ANGB
BORING FT-2, B-1



Light brown, semi-stiff, low plasticity, fine clayey sand; no odor

Same with some gypsum

Grades to higher gypsum content

With layer of charred material

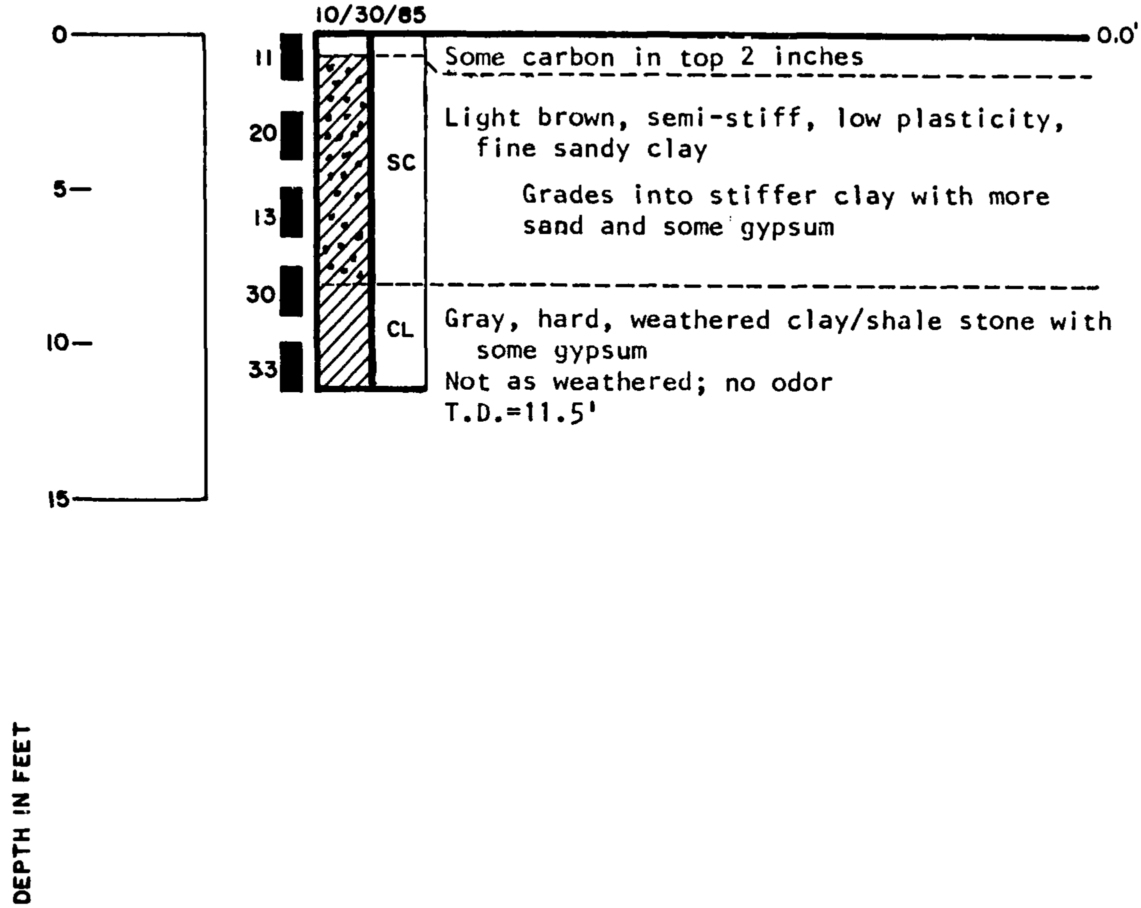
T.D.=11.5' in gray hard claystone; no odor

LOG OF BORING

Dames & Moore

BUCKLEY ANGB
BORING FT-2, B-2

10/30/85



Some carbon in top 2 inches

Light brown, semi-stiff, low plasticity, fine sandy clay

Grades into stiffer clay with more sand and some gypsum

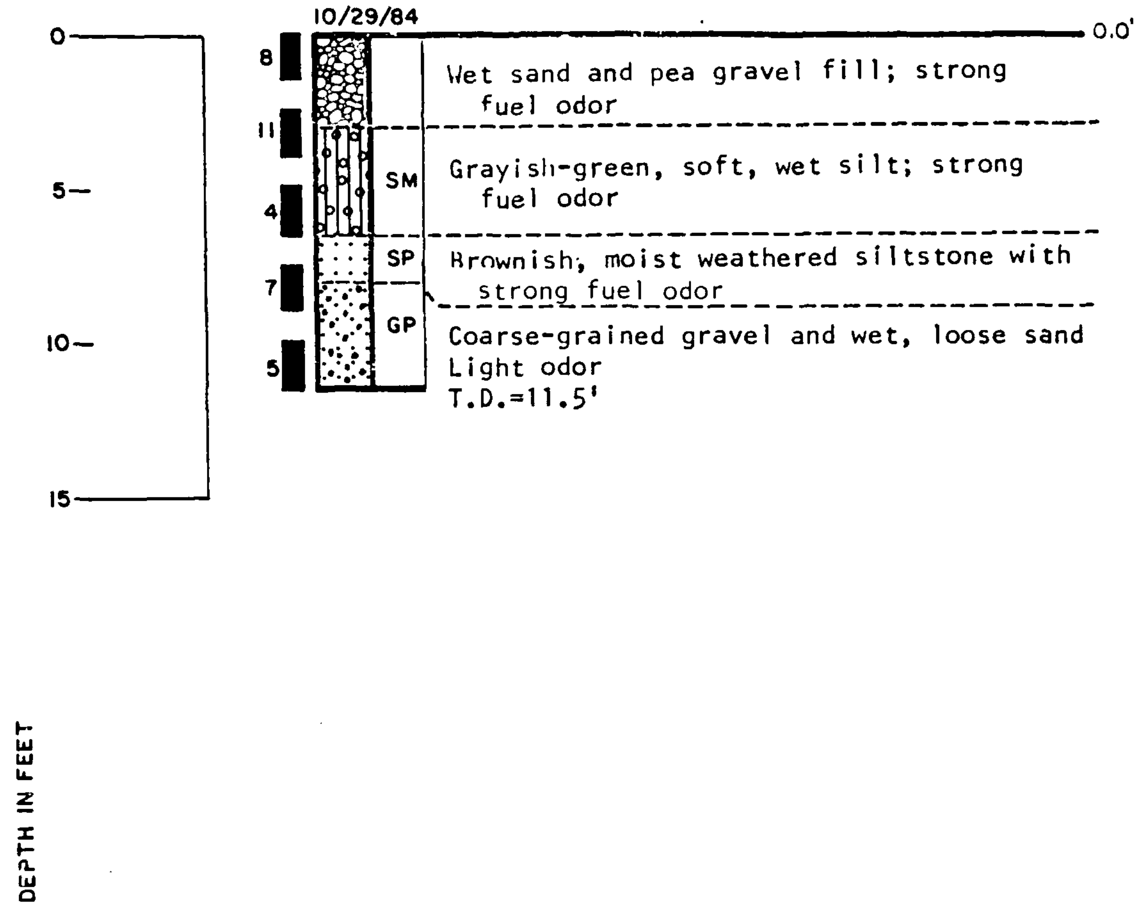
Gray, hard, weathered clay/shale stone with some gypsum
Not as weathered; no odor
T.D.=11.5'

LOG OF BORING

Dames & Moore

PLATE C-8

BUCKLEY ANGB
BORING FT-3, B-1



LOG OF BORING

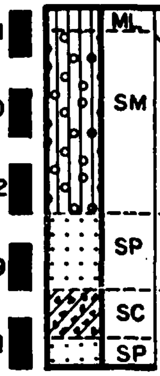
Dames & Moore

BUCKLEY ANGB
BORING FT-3, B-2

10/29/84

DEPTH IN FEET

Depth	Blows	Symbol	Description
0	11	ML	Fill and topsoil
	20	SM	Dark brown, dry, tightly packed silty sand with some pea gravel in the top 6"; slight odor
5	12		Grayish-brown, hard, weathered siltstone/ clay stone; no odor
	9	SP	Medium to fine grained, loose, moist sand; slight odor
10		SC	Sandy claystone with white mottling
	11	SP	Fine to medium, clean dry sand; no odor
15			



0.0'

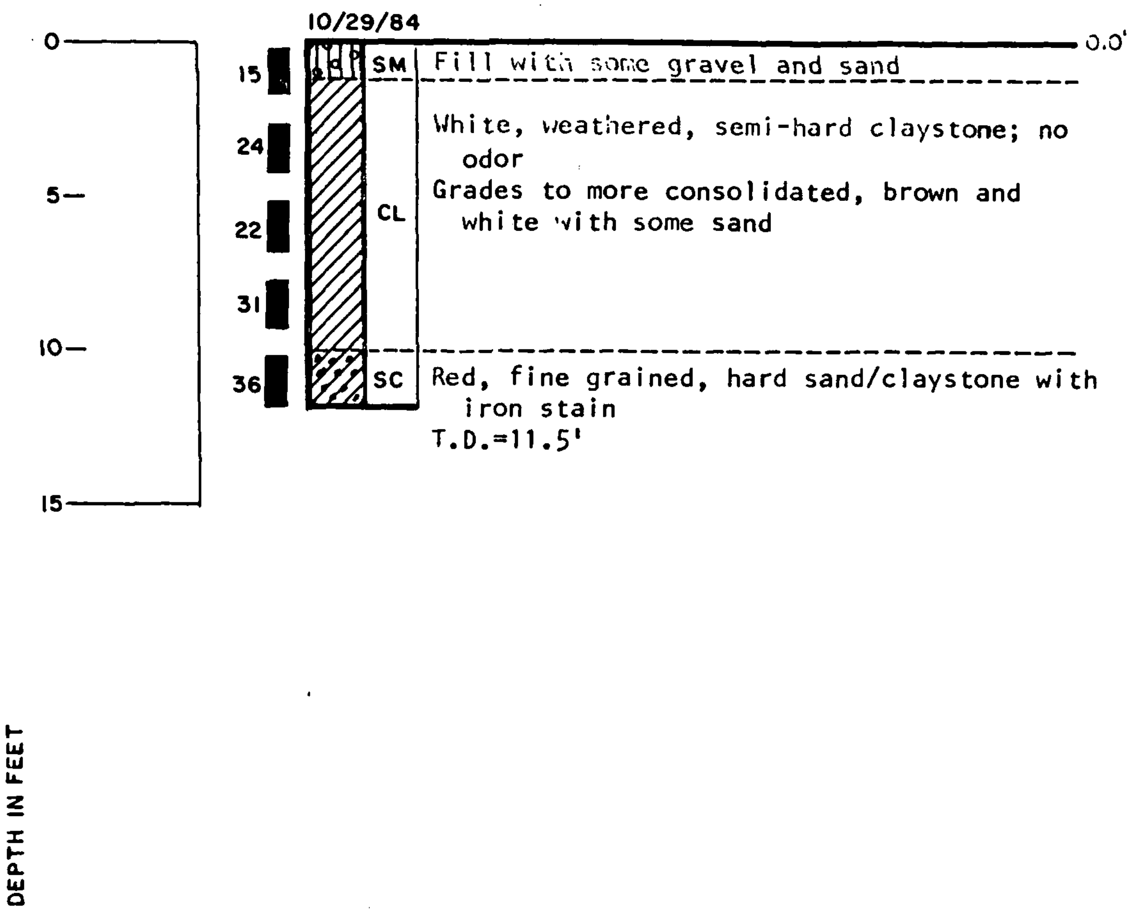
T.D.=11.5'

LOG OF BORING

Dames & Moore

PLATE C-10

BUCKLEY ANGB
BORING FT-1, B-1

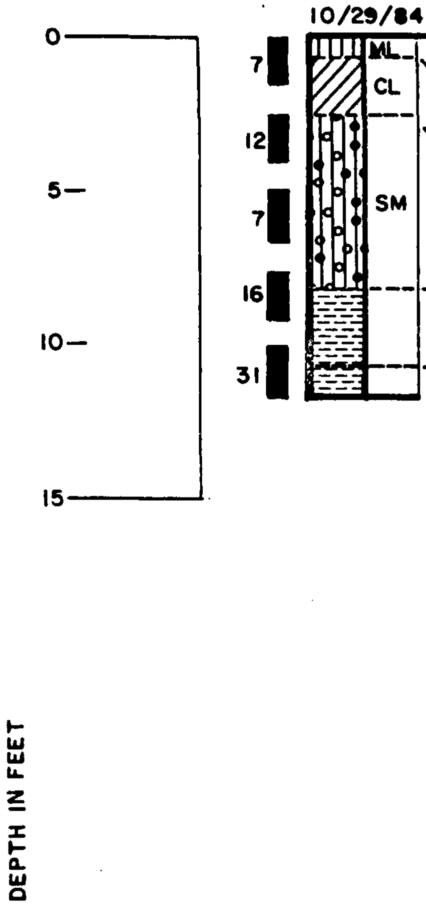


LOG OF BORING

Dames & Moore

BUCKLEY ANGB
BORING FT-1, B-2

10/29/84



0.0'

Topsoil

Medium brown, semi-soft, medium plasticity, clay

Dark brown, stiff, low plasticity, silty sand

Reddish-brown, crumbly siltstone

Reddish-brown, sand/silt stone with pockets of gypsum

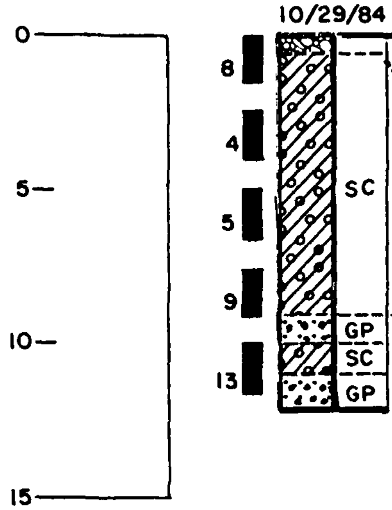
T.D.=11.5'

LOG OF BORING

Dames & Moore

BUCKLEY ANGB
BORING SITE 5, B-1

10/29/84



Sand and loose gravel

Light brown, soft, fine to medium sandy clay with some scattered pea gravel and some white clayey areas, no odor

Medium to coarse, loose sand; no odor

Some sandy clay

Some sand

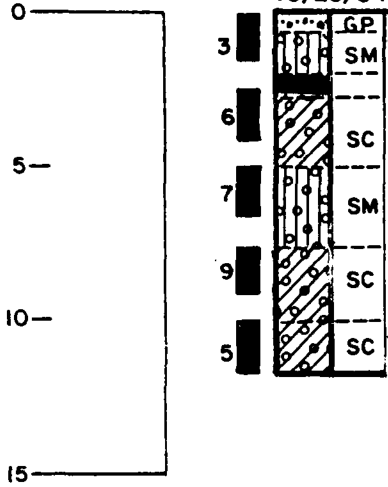
T.D.=11.5' Water was encountered at the surface

LOG OF BORING

Dames & Moore

BUCKLEY ANGB
BORING SITE 5, B-2

10/29/84



0.0'

Gravel
Gray silt
Grayish-black sludge; some odor
Gray, soft, moist sandy clay with black staining; light odor
Light gray, silty sand with dark and light spots; no odor
Stiff, medium sandy clay with iron stains; no odor
Grades to more clay
Gray, stiff, sandy clay; no odor
T.D.= 11.5'
Water was encountered at the surface

LOG OF BORING

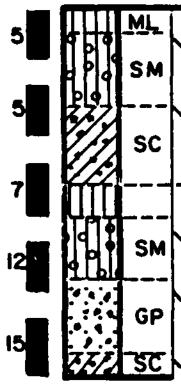
Dames & Moore

PLATE C-14

BUCKLEY ANGB
BORING SITE 5, B-3

10/29/84

0.0'



Topsoil

Light brown, soft, medium plasticity, silty sand; no odor

Light brown, soft, low plasticity, very fine sandy clay; no odor

White, very fine, moist, no plasticity silt (Rock flour)

Brown coarse sand with some silt

Coarse sand

T.D.=11.5'

0—
5—
10—
15—

DEPTH IN FEET

LOG OF BORING

Dames & Moore

PLATE C-15

BUCKLEY ANGB
BORING SITE 5, B-3

10/29/84

Blows	Soil	Description
		0.0'
5	ML	Topsoil
	SM	Light brown, soft, medium plasticity; no odor
5	SC	Light brown, somewhat clayey, very fine sand, soft, low plasticity; no odor
7	ML	White, rock flour, very fine, low plasticity; no odor
12	SM	Brown, some silt
15	GP	Large grain sand, very clean
		T.D.=11.5', clean hole

DEPTH IN FEET: 0, 5, 10, 15

LOG OF BORING

Dames & Moore

PLATE C-16

APPENDIX C (continued)

PRIVATE WELLS IN THE VICINITY OF
BUCKLEY ANGB, COLORADO
LISTED BY LOCATION

ICAE-RT, DIVISION OF WATER RESOURCES, GROUND WATER SECTION, MASTER EXTRACT LIST

FULL MASTER LIST BY LOCATION

FILE CONTROL D-CT-PERMIT	OWNER NAME/S	STREET ADDRESS	CITY	ZIP	ST	W D	N D	D R	P M	RANGE	TOWN SHIP	SEC	SEC LOCAT'N COORDINATES	QUARTER SECTIONS	USE	DATE	WELL YIELD	WELL DPTH	WATR LVEL	ANNUAL APPROP	IRR. ACRS	GEOL AQUIFER
1-01-013792R	PERROTT FARMS INC	16631E COLFAX	DENVER	8	CO	02	99	99	S	066 0W	03 0S	33		SW NW	6	[illegible]-54	600.0	50	15	.0		0
1-01-013793R	PERROTT FARMS INC	16631 E COLFAX	DENVER		CO	02	99	99	S	066 0W	03 0S	33		SW NW	6	[illegible]-53	200.0	47	24	.0		0
1-01-019877R	STEARNS-ROGERS CORPORATION	P O BOX 388	DENVER	8021	CO	02	99	99	S	066 0W	03 0S	33		SE NE	6	04-12-42	350.0	50	20	.0		0
1-01-019877S	STEARNS-ROGER CORPORATION	P O BOX 388	DENVER	8021	CO	02	99	99	S	066 0W	03 0S	33	2125N,02950	SE NE	6	04-12-42	350.0	50	20	.0	30	
1-01-019877T	STEARNS-ROGER CORPORATION	P O BOX 5388	DENVER	8021	CO	02	99	99	S	066 0W	03 0S	33	1391N,13076	SE NE	6	07-12-44	750.0	50	20	.0	30	
1-01-019877U	STEARNS-ROGER CORPORATION	P O BOX 5388	DENVER	8021	CO	02	99	99	S	066 0W	03 0S	33	0400N,13420	NE NE	6	07-12-42	790.0	45	20	.0	30	
1-01-022030	DENVER BOARD WATER COMMISSI	144 W COLFAX	DENVER		CO	02	99	99	S	066 0W	03 0S	33		SE SE	9	10-14-44	10.0	73	26	.0		0
1-01-022168	ED M HONNEN COMPANY	3450 E SYRACUSE C0263	ENGLEWOOD	80110	CO	02	99	99	S	066 0W	03 0S	33		SE SE	3	11-[illegible]-44	40.0	403	290	.0		0
1-01-036490	DENVER BOARD OF WATER COMMI	144 W COLFAX AVE	DENVER		CO	02	99	99	S	066 0W	03 0S	33		SE SE	1	02- -44	40.0	70	20	.0		0
1-01-003284	SMITH LAWRENCE A	RT 3 BX 32A	DENVER		CO	02	99	99	S	066 0W	03 0S	34		NE NW	1	08-18-59	12.0	350	140	.0		0
1-01-004301	KALLENBACH W H	RR 3 BOX 87	AURORA		CO	02	99	99	S	066 0W	03 0S	34		NW SW	1	07-02-40	13.0	42	12	.0		0
1-01-006879	BOBINETT W F	2252 TOWER RD	AURORA		CO	02	99	99	S	066 0W	03 0S	34		SW NW	1	04-17-41	6.0	100	20	.0		0
1-01-009213F	TOWER NURSERY GREENHOUSE	17050 SMITH RD	AURORA		CO	02	99	99	S	066 0W	03 0S	34		SW NW	4	04-24-43	120.0	45	30	.0		0
1-01-010740	WILLIAMS ROB	BOX 202	DENVER	8	CO	02	99	99	S	066 0W	03 0S	34		SE NE	1	03-02-43	25.0	335	140	.0		0
1-01-011310F	SHAFFER FRED E	2020 TOWER RD	AURORA		CO	02	99	99	S	066 0W	03 0S	34		SW NW	6	11-21-44	100.0	48	32	.0		0
1-01-011639	ACKARD LAND CO	1742 SHERMAN ST	DENVER		CO	02	99	99	S	066 0W	03 0S	34		SE NW	1	04-20-42	2.0	144	35	.0		0
1-01-013143	MCAFEE G L	1790 PIKE ST	AURORA		CO	02	99	99	S	066 0W	03 0S	34		NW SW	1	11-10-52	3.0	38	17	.0		0
1-01-016081R	MATTSON FRED W MATTSON A B	675 PET CLB BLDG 675 PET CLB BLDG	DENVER DENVER		CO CO	02	99	99	S	066 0W	03 0S	34		NW SW	8	03-02-55	113.0	944	250	.0		0
1-01-017062	DURAN MORRIS	1791 MILLS ST	AURORA		CO	02	99	99	S	066 0W	03 0S	34		NW SW	1	09-01-42	10.0	30	10	.0		0
1-01-017338	BLACKWELL GEORGE	1771 MILLS	AURORA		CO	02	99	99	S	066 0W	03 0S	34		NW SW	1	08-30-43	.0	37	23	.0		0
1-01-019532	JESSE JACOB	RT 3 BOX 65	AURORA		CO	02	99	99	S	066 0W	03 0S	34		NW NW	1	04-28-44	4525.0	60	0	.0		0
1-01-019598	DENNING ELMER K	18781 E 19TH AVE	AURORA		CO	02	99	99	S	066 0W	03 0S	34		SE NW	1	04-28-44	5.0	33	24	.0		0
1-01-021471	SMITH LAWRENCE A	19200 SMITH RD	AURORA		CO	02	99	99	S	066 0W	03 0S	34		NE NW	1	06-11-44	13.0	345	180	.0		0

DATE OF UPDATE IS 08-07-84

**** E 01 ****

ICAE-RT, DIVISION OF WATER RESOURCES, GROUND WATER SECTION, MASTER EXTRACT LIST

FULL MASTER LIST BY LOCATION

FILE CONTROL D-CT-PERMIT	OWNER NAME/S	STREET ADDRESS	CITY	ZIP	ST	W D	N D	D R	P M	RANGE	TOWN SHIP	SEC	SEC LOCAT'N COORDINATES	QUARTER SECTIONS	USE	DATE	WELL YIELD	WELL DPTH	WATR LVEL	ANNUAL APPROP	IRR. ACRS	GEOL AQUIFER
1-01-028601	EMMERLING FRANK R	RT 3 BOX 35	AURORA		CO	02	99	99	S	066 0W	03 0S	34		NE NW	1	08-29-66	16.0	597	142	.0		0
1-01-030605	MCAFEE GEORGE	1760 ARAGON ST	AURORA		CO	02	99	99	S	066 0W	03 0S	34		SW SW	1	04-20-67	7.0	65	18	.0		0
1-01-040729	HAYS CARL	1670 CEYLON	AURORA		CO	02	99	99	S	066 0W	03 0S	34		SE SW	1	03-27-70	15.0	50	25	.0		0
1-01-045015	HAGEMANN ALPHIUS E HAGEMANN EDNA M	RT 3 RT 3	AURORA AURORA		CO CO	02	99	99	S	066 0W	03 0S	34		SW NW	3	09-30-63	12.0	48	35	.0		0
1-01-046476	PATTERSON GEORGE L	2240 TOWER RD	AURORA		CO	02	99	99	S	066 0W	03 0S	34		NW NW	1	05-29-71	9.0	310	135	.0		C
1-01-061230	CRISMAN, HELEN M	1700 BANANA ST	AURORA		CO	02	99	99	S	066 0W	03 0S	34		SW SW	1	05-12-56	10.0	60	0	.0		0
1-01-002158F	EASTLAWN MEMORIAL GARDENS I	1465 BOSTON ST	DENVER	8	CO	02	99	99	S	066 0W	03 0S	35		SW NW	6	05-20-59	35.0	1222	UNK	.0		0
1-01-002377F	DYER J E	P O BX 5306	DENVER	17	CO	02	99	99	S	066 0W	03 0S	35		NW NW	4	12-10-59	75.0	1230	300	.0		0
1-01-02906Y	KEIL WALTER C KEIL BARBARA	21591 E COLFX AVE 21591 E COLFX AVE	AURORA AURORA		CO CO	02	99	99	S	066 0W	03 0S	35		SE SE	1	10-13-66	30.0	704	170	.0		0
1-01-011606	KIMMEL DONALD	7469 KEARNEY ST	DERBY		CO	02	99	99	S	066 0W	02 0S	02		SE SE	1	06-12-62	7.0	240	66	.0		0
1-01-012287	KIMMEL JAMES	5818 POPLAR	DENVER	16	CO	02	99	99	S	066 0W	02 0S	02		SE SE	2	07-26-62	3.0	67	32	.0		0
1-01-014565	SHRIVER DONALD	7062 PEARL	DENVER	3	CO	02	99	99	S	066 0W	02 0S	02		SW SE	1	03-29-63	8.0	100	45	.0		0
1-01-019371	BRIGGS ROBERT E	5932 MAGNOLIA	COMMRCE CT		CO	02	99	99	S	066 0W	02 0S	02		NE SE	1	05-06-64	12.0	275	101	.0		0
1-01-021539	CHAPMAN ALBERT	RT 1 BOX 3A	COMMRCE CT		CO	02	99	99	S	066 0W	02 0S	02		SW SE	1	09-19-64	7.0	195	185	.0		0
1-01-025367	YOUNGER ROBERT J	RT 2 BOX 87 A	BRIGHTON	80601	CO	02	99	99	S	066 0W	02 0S	02		NE SE	1	09-14-65	3.0	83	72	.0		0
1-01-030606	QUINBY JOHN	7135 E 60TH WAY	COMM CITY	80022	CO	02	99	99	S	066 0W	02 0S	02		SE SE	1	08-25-67	6.0	195	140	.0		0
1-01-035956	PIETRAFESS GEORGE R	6410 PORTER WAY	COMMRCE CT		CO	02	99	99	S	066 0W	02 0S	02		SE SE	1	12-04-68	10.0	240	88	.0		0
1-01-037195	YOUNGER ROBERT T	RT 2 BOX 87A	BRIGHTON		CO	02	99	99	S	066 0W	02 0S	02		NE SE	1	04-03-69	10.0	300	160	.0		0
1-01-039732	BOHLMYER ELCON L	RT 1 BOX 42	COMMRCE CT		CO	02	99	99	S	066 0W	02 0S	02		NE SE	1	11-11-69	23.0	132	131	.0		0
1-01-043272	MUSSELMAN, [illegible]	[illegible]																				

FILE CONTROL D-CT-PERMIT NUMBER	OWNER NAME/S	STREET ADDRESS	CITY	ZIP	ST	W D	W D	D B	P M	RANGE	TOWNSHIP	SEC	SEC LOCAT'N COORDINATES	QUARTER SECTIONS	USE	DATE	WELL YIELD	WELL DPTH	WATR LVEL	ANNUAL APPROP	IRR ACRS	BSIC AQUIFER
1-01-015735F	GERKEN, ROBERT	3075 POTOMAC	AURORA	80012	CO	02	99	99	S	066	0W	03 0S	31		SW NW	6	08-11-71	80.0	1115	330	.0	0
1-01-016011	SCHACHER EUGENE	16020 26TH AVE	AURORA		CO	02	99	99	S	066	0W	03 0S	31		NE NW	1	[illegible]-20-63	[illegible]	[illegible]	[illegible]	.0	0
1-01-016478	HARNESS THOMAS L	2483 ZION	AURORA		CO	02	99	99	S	066	0W	03 0S	31		NW NW	1	07-21-57	10.0	[illegible]	[illegible]	.0	0
1-01-016797	FERGUSON J T	2634 ZION	AURORA		CO	02	99	99	S	066	0W	03 0S	31		NW NW	1	06-10-65	15.0	[illegible]	18	.0	0
1-01-017725	JOHNSON HAROLD	2602 ALTURA ST	AURORA		CO	02	99	99	S	066	0W	03 0S	31		NE NW	1	10-23-63	5.0	[illegible]	230	.0	0
1-01-019331	WELLS D CLARK	2433 ZION	AURORA		CO	02	99	99	S	066	0W	03 0S	31		NW NW	1	06-29-64	11.0	[illegible]	33	.0	0
1-01-019942	FRANCE ROBERT W	16204E 24TH AVE	AURORA		CO	02	99	99	S	066	0W	03 0S	31		SW NW	1	05-20-64	7.0	[illegible]	40	.50	0
1-01-027452	COOP OLIVER A	2041 FAIRPLAY ST	AURORA		CO	02	99	99	S	066	0W	03 0S	31		SE NE	1	05-13-66	5.0	30	31	.0	0
1-01-030121	DEBECK HENRY MRS	1941 CHAMBERS RD	AURORA		CO	02	99	99	S	066	0W	03 0S	31		NE SE	1	03-16-67	5.0	67	35	.0	0
1-01-030490	KIZER H S	1870 ALTURA	AURORA		CO	02	99	99	S	066	0W	03 0S	31		NE SE	1	04-07-67	[illegible]	44	26	.0	0
1-01-030722	GORTZINGER J J	16085 E 23RD AVE	AURORA		CO	02	99	99	S	066	0W	03 0S	31		SE NE	1	05-05-67	10.0	40	31	.0	0
1-01-034066	HILLS JAMES T	16203 E 23RD AVE	AURORA		CO	02	99	99	S	066	0W	03 0S	31		SE NW	1	10-01-68	10.0	[illegible]	32	.0	0
1-01-034263	CHAMBERS CHAS REV	3300 HELENA ST	AURORA		CO	02	99	99	S	066	0W	03 0S	31		SW NW	1	06-06-68	15.0	[illegible]	34	.50	0
1-01-042448	HARTMAN ROGER	14191 E 23RD AVE	AURORA		CO	02	99	99	S	066	0W	03 0S	31		NW NW	1	08-20-70	5.0	[illegible]	34	.0	0
1-01-051188	DIAZ, GIRALDO L.	14276 E. 25TH PL	AURORA		CO	02	99	99	S	066	0W	03 0S	31		NW NW	1	03-04-72	10.0	[illegible]	31	.0	0
1-01-056333	HUNEY, GERALD A	2301 ZION ST	AURORA	80010	CO	02	99	99	S	066	0W	03 0S	31		SW NW	1	04-27-74	15.0	[illegible]	14	[illegible]	NB UNC
1-01-123099	SCHMIDT, PAUL	2110 EAGLE CIRCLE	AURORA	80011	CO	02	99	99	S	066	0W	03 0S	31	3100S,1951E	SE NW	1	04-16-81	5.0	[illegible]	[illegible]	1.0	0
1-01-000118	BENNETT E	1940 CHAMBERS RD	DENVER 8		CO	02	99	99	S	066	0W	03 0S	32		NW NW	1	08-17-57	[illegible]	[illegible]	[illegible]	.0	0
1-01-000426	COOP OLIVER A	3730 CHAMBERS RD	AURORA		CO	02	99	99	S	066	0W	03 0S	32		SE NW	1	12-20-57	8.0	200	0	.0	0
1-01-000439	GLENN W D	3423 ST PAUL ST	DENVER 6		CO	02	99	99	S	066	0W	03 0S	32		SE SE	1	12-26-57	25.0	1083	200	.0	0
1-01-003013F	WELL COMPLETION CO	BOX 1336	DENVER 1		CO	02	99	99	S	066	0W	03 0S	32		SE NW	6	03-16-61	135.0	12	1	.0	0
1-01-003176	BUCKLEY LEONARD	16431E COLFAX AV	DENVER 8		CO	02	99	99	S	066	0W	03 0S	32		SW SW	1	04-16-59	33.0	1020	0	.0	0
1-01-003485	BERRIER ROLAND G	2230 CHAMBERS RD	AURORA 8		CO	02	99	99	S	066	0W	03 0S	32		SW NW	1	03-23-59	1.0	230	100	.0	0
1-01-004871	AIKEN JAMES R	RT 3 BX 13	AURORA		CO																	

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IGAE-RT, DIVISION OF WATER RESOURCES, GROUND WATER SECTION, MASTER EXTRACT LIST

FULL MASTER LIST BY LOCATION

FILE CONTROL D-CT-PERMIT NUMBER	OWNER NAME/S	STREET ADDRESS	CITY	ZIP	ST	W D	W D	D B	P M	RANGE	TOWNSHIP	SEC	SEC LOCAT'N COORDINATES	QUARTER SECTIONS	USE	DATE	WELL YIELD	WELL DPTH	WATR LVEL	ANNUAL APPROP	IRR ACRS	BSIC AQUIFER
						02	99	99	S	066	0W	03 0S	32		NW NW	1	12-12-59	12.0	87	12	.0	0
1-01-005136	OBERG DEE L	15345E COLFAX AV	AURORA		CO	02	59	99	S	066	0W	03 0S	32		SW SW	1	01-18-60	19.0	342	320	.0	0
1-01-013794R	PERROTT FARMS INC	16631E COLFAX	DENVER 8		CO	02	99	99	S	066	0W	03 0S	32		SE SE	6	- -55	400.0	6	6	.0	0
1-01-015737	KEMP CHARLES	2490 TOWER RD	AURORA		CO	02	99	99	S	066	0W	03 0S	32		NW NW	1	06-08-63	4325.9		0	.0	0
1-01-023462	JAMES ROBERT E	1895 CHAMBERS RD	AURORA		CO	02	99	99	S	066	0W	03 0S	32		NW SW	1	04-20-65	8.0	53	28	.0	0
1-01-026433	COLORADO DEPT OF HIGHWAYS	16500 E COLFAX	AURORA		CO	02	99	99	S	066	0W	03 0S	32		SW SW	1	03-08-66	75.0	727	147	.0	0
1-01-028622	EMPIRE SAND & GRAVEL CO	16000 SMITH RD	AURORA		CO	02	99	99	S	066	0W	03 0S	32		NE NW	1	08-29-66	15.0	23	11	.0	0
1-01-048029	HULSE FLOYD	2202 TOWER RD	AURORA		CO	02	99	99	S	066	0W	03 0S	32		SE NE	1	08-09-71	15.0	37	14	.0	0
1-01-121465	COPENHAVER, MARIE	2300 CHAMBERS RD	AURORA	80011	CO	02	99	99	S	066	0W	03 0S	32	0050N,1400W	NE NW	1	00-00-50	12.0	60		2.0	1
1-01-002312F	ED M HONNEN COMPANY	5650 S SYRACUSE CR265	ENGLEWOOD	80110	CO	02	99	99	S	066	0W	03 0S	33	01515,2095E	SW SE	6	10-20-59	115.0	34	0	.0	0
1-01-004564	ED M HONNEN COMPANY	5650 S SYRACUSE CR265	ENGLEWOOD	80110	CO	02	99	99	S	066	0W	03 0S	33		NE SE	3	10-15-59	210.0	41	0	.0	0
1-01-005615F	HEADRICK CHARLES W	RT 3 BOX 48	AURORA		CO	02	99	99	S	066	0W	03 0S	33		NW NE	6	05-09-64	250.0	53	10	.0	0
1-01-008235R	OPUS CORPORATION	P.O. BOX 150	MINNEAPOLI	55440	MN	02	99	99	S	066	0W	03 0S	33	2053S,0544E	NE SE	6	- -33	150.0	37	19	.0	0
1-01-008236R	OPUS CORPORATION	P.O. BOX 150	MINNEAPOLI	55440	MN	02	99	99	S	066	0W	03 0S	33	1737S,0471E	NE SE	6	- -35	215.0	43	21	.0	0
1-01-009237R	ED M HONNEN COMPANY	5650 E SYRACUSE CR	ENGLEWOOD	80110	CO	02	99	99	S	066	0W	03 0S	33	1274S,0278E	SE SE	6	- -40	300.0	40	13	.0	0
1-01-008238R	ED M HONNEN COMPANY	5650 S SYRACUSE CR	ENGLEWOOD	80110	CO	02	99	99	S	066	0W	03 0S	33	0774S,0569E	SE SE	6	- -45	325.0	39	13	.0	0
1-01-008239R	MCCOY CO	BX 5108 T A	DENVER		CO	02	99	99	S	066	0W	03 0S	33		SW SE	6	- -45	264.0	32	13	.0	0
1-01-008240R	ED M HONNEN COMPANY	5650 S SYRACUSE CR	ENGLEWOOD	80110	CO	02	99	99	S	066	0W	03 0S	33	0437S,0046E	SE SE	6	- -48	400.0	40	12	.0	0
1-01-008241R	ED M HONNEN COMPANY	5650 S SYRACUSE CR	ENGLEWOOD	80110	CO	02	99	99	S	066	0W	03 0S	33	0186S,0673E	SE SE	6	- -55	300.0	38	15	.0	0
1-01-010343R	ED M HONNEN COMPANY	5650 SO SYRACUSE CR	ENGLEWOOD	80110	CO	02	99	99	S	066	0W	03 0S	33	1226S,0057E	SE SE	6	- -45	175.0	32	10	.0	0
1-01-010344R	MCCOY COMPANY	BX 5108 T A	DENVER		CO	02	99	99	S	066	0W	03 0S	33		SE SW	6	- -45	150.0	30	12	.0	0
1-01-013667F	CONNERS R E ESTATE OF GUINN LUCILLE C EXECUTRIX	16901 E COLFAX AVE 16901 E COLFAX AVE	AURORA AURORA		CO CO	02	99	99	S	066	0W	03 0S	33		SW SW	6	- -38	200.0	31	8	.0	0
1-01-013668F	GUINN LUCILLE C EXECUTRIX CONNERS R E ESTATE OF	16901 E COLFAX AV 16901 E COLFAX AV	AURORA AURORA		CO CO	02	99	99	S	066	0W	03 0S	33		SW SW	6	- -38	350.0	31	8	.0	0

FILE CONTROL D-CT-PERMIT NUMBER	OWNER NAME/S	STREET ADDRESS	CITY	ZIP	ST	D	W D	D B	P M	RANGE	TOWN SHIP	SEC	SEC LOCAT'N COORDINATES	QUARTER SECTIONS	USE	DATE	WELL YIELD	WELL DPTH	WATR LVEL	ANNUAL APPROP	IRR. ACRS	GEOL AQUIFER
1-03-028005	KUEHNEL HAROLD	925 MACON ST	AURORA		CO	02	99	99	S	066 0W	04 0S	11		NE NE	1	07-13-66	9.0	38	24	.0	0	
1-03-028906	SHOCKLEY EUGENE M	13801 EVERGREEN AVE	AURORA		CO	02	99	99	S	066 0W	04 0S	11		NE NE	1	10-03-66	20.0	46	23	.0	0	
1-03-031336	WILEY BERTHA	1868 S OGDEN ST	DENVER		CO	02	99	99	S	066 0W	04 0S	11		NW SE	1	04-26-67	2.0	120	55	.0	0	
1-03-079792	HEINTZ, F. E.	376 OAKLAND	AURORA	80010	CO	02	99	99	S	066 0W	04 0S	11	00908,04738	SE SE	1	04-27-75	15.0	415	167	1.0	1	NO SBU
1-03-010401	ABRAHAMSEN MARTIN	321 [illegible]	DENVER 8		CO	02	99	99	S	066 0W	04 0S	12		NW SE	2	11-25-61	2.0	43	10	.0	0	
1-03-027387	SMITH B E	8030 SENECA	ENGLEWOOD		CO	02	99	99	S	066 0W	04 0S	12		SE SW	1	09-22-66	20.0	140	110	.0	0	
1-03-032277	BIG BAIT CO INC	1160 VERBENA ST	DENVER		CO	02	99	99	S	066 0W	04 0S	12		SE SW	2	10-12-67	15.0	30	18	.0	0	
1-03-040228	BECKER HERBERT	1673 CHESTER	AURORA		CO	02	99	99	S	066 0W	04 0S	12		NW SE	2	04-01-70	30.0	32	19	.0	0	
1-03-042112	FIX MAURICE J	1124 JOLIET ST	DENVER		CO	02	99	99	S	066 0W	04 0S	12		SE SE	1	08-13-70	15.0	42	18	.0	0	
1-03-045188	TORRES MAX D	4647 COLUMBINE ST	DENVER		CO	02	99	99	S	066 0W	04 0S	12		SE SE	1	03-31-71	5.0	54	22	.0	0	
1-03-050846	GILCHRIST, MARY D	1321 S WASHINGTON	DENVER	80210	CO	02	99	99	S	066 0W	04 0S	12		SE SW	1	06-01-74	15.0	40		.0	0	NO SBU
1-03-060327	LINSON, MARVIN G	4992 SO XENIA	DENVER	80237	CO	02	99	99	S	066 0W	04 0S	12	10425,01930	SE SE	3	07-10-67	15.0	0	0	10.0	0	
1-03-073152	BERYMAN, ARNOLD	3143 S. FLORIDA	DENVER	80231	CO	02	99	99	S	066 0W	04 0S	12	11400,21000	SW SE	1	03-08-74	10.0	600	20	1.0	1	NO SBU
1-03-033274	AURORA SPORTSMAN	BOX 743	AURORA		CO	02	99	99	S	066 0W	04 0S	13		NE NE	1	06-06-68	10.0	29		.0	0	
1-03-016118R	COLO AIR NATL GUARD		DENVER 30		CO	02	99	99	S	066 0W	04 0S	14		SE NW	8	-42	141.0	1100	311	.0	0	
1-03-030228	HAINES CARL J	RT 3 BOX 312	AURORA		CO	02	99	99	S	066 0W	04 0S	14		SE SE	1	09-12-53	.0	13	142	.0	0	
1-03-050376	KIBBLE, ALBERT F	2290 TOWER RD	AURORA	80011	CO	02	99	99	S	066 0W	04 0S	15		NE NW	1	10-06-71	10.0	410	375			NO SBU
1-03-005955	BARR MAURICE	2690 S HIGH ST	DENVER		CO	02	99	99	S	066 0W	04 0S	18		NW SW	1	04-10-60	20.0	1061	300	.0	0	
1-03-017933F	AURORA MALL ASSOCIATES DEBARTOLO, EDWARD J & ASSOC	P.O. BOX 3287 PO BOX 3287	YOUNGSTOWN	44513	OH	02	99	99	S	066 0W	04 0S	18	33840,34205	SE NW	6	12-13-74	96.0	1400	300	36.0	129	
1-03-034964	PARKER JIM	808 S POTOMAC	AURORA		CO	02	99	99	S	066 0W	04 0S	18		SW SW	1	08-01-68	15.0	1150	340	.0	0	
1-03-079762	WESTLAKE, DONALD J.	1360 S. ALTON ST.	DENVER	80231	CO	02	99	99	S	066 0W	04 0S	18	08305,02000	SE SE	1	10-00-75	15.0	490	264		1	NO SBU
1-03-019031F	AURORA PUBLIC SCHOOLS	1399 BUCKLEY RD	AURORA	80011	CO	02	99	99	S	066 0W	04 0S	19	2030N,31305	SW NE	6	07-01-74	75.0	1332	290	10.0	13	
1-03-000585	GENIER JIM	1630 S CHAMBERS RD	DENVER 31		CO	02	99	99	S	066 0W	04 0S	20		SW SW	1	12-06-57	1.0	100	0	1.0		

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ICAF-AT, DIVISION OF WATER RESOURCES, GROUND WATER SECTION, MASTER EXTRACT LIST

FULL MASTER LIST BY LOCATION

FILE CONTROL D-CT-PERMIT NUMBER	OWNER NAME/S	STREET ADDRESS	CITY	ZIP	ST	D	W D	D B	P M	RANGE	TOWN SHIP	SEC	SEC LOCAT'N COORDINATES	QUARTER SECTIONS	USE	DATE	WELL YIELD	WELL DPTH	WATR LVEL	ANNUAL APPROP	IRR. ACRS	GEOL AQUIFER
1-03-001865	CORRIN O E SR	1340 S CHAMBERS RD	DENVER 8		CO	02	99	99	S	066 0W	04 0S	20		NW SW	1	09-20-58	15.0	940	200	.0	0	
1-03-011965	PRYOR L D	1400 S CHAMBERS RD	AURORA		CO	02	99	99	S	066 0W	04 0S	20		SW NW	1	08-20-62	.0	943	6A17	.0	0	
1-03-019648F	NORTH DIV NAVAL FACIL ENG	BLDG 77L CODE 114	PHILADELPH	19112	PA	02	99	99	S	066 0W	04 0S	23	2200N,0760E	SE NE	9	04-26-76	25.0	745	310	1.3		
1-03-048820	BUCHER JACK E	1221 EAGLE ST	AURORA		CO	02	99	99	S	066 0W	04 0S	23		SW SE	1	09-13-71	14.0	200	40	.0	0	
1-03-014667	WEST ARAPAHOE SOIL CONSERVA	90 JOHN RACE	PARKER		CO	02	99	99	S	066 0W	04 0S	25		SE SE	2	04-08-63	2.0	37	11	.0	0	
1-03-008067	WERNTZ GARY	11035E ASBURY	DENVER		CO	02	99	99	S	066 0W	04 0S	26		NE NW	1	03-14-61	10.0	100	40	.0	0	
1-03-020102F	AURORA PUBLIC SCHOOLS	1085 PEORIA ST	AURORA	80011	CO	02	99	99	S	066 0W	04 0S	28	0550N,3210E	NE NW	6	06-18-76	75.0	1360	115	6.0	6	
1-03-031351	MOSS HOWARD	1812 S CHAMBERSRD	AURORA		CO	02	99	99	S	066 0W	04 0S	29		SW NE	1	07-11-67	10.0	1007	87	.0	0	
1-03-005063	CRUM E	2085 S CHAMBERS RD	DENVER 31		CO	02	99	99	S	066 0W	04 0S	30		NE NE	1	01-15-60	4.0	330	20	.0	0	
1-03-031163	THOMPSON JOHN H	2001 S CHAMBERS RD	[illegible]		CO	02	99	99	S	066 0W	04 0S	30		NE NE	1	04-10-67	9.0	100	10	.0	0	
1-03-047125	EVANS NORMAN L	2201 S CHAMBERS RD	DENVER 18		CO	02	99	99	S	066 0W	04 0S	30		SE NE	1	06-21-71	.0	303	76	.0	0	
1-03-034195	WEST ARAPAHOE SOIL CONSERVA		PARKER	80134	CO	02	99	99	S	066 0W	04 0S	33	10500,0300E	SE SE	1	04-10-68	15.0	400	160	2.0	0	
1-01-010622R	REITHER JOHN	RT 1 BX 99	DERBY		CO	02	99	99	S	066 0W	03 0S	04		NE SW	6	04- -53	450.0	65	0	.0	0	
1-01-010623R	REITHER JOHN	RT 1 BX 99	DERBY		CO	02	99	99	S	066 0W	03 0S	04		NE SW	6	04- -57	200.0	56	76	.0	0	
1-01-010827R	NORTH COLO PROP LTD	1776 SO JACKSON ST	DENVER	80210	CO	02	99	99	S	066 0W	03 0S	04		SW NW	6	- -56	200.0	40	22	.0	0	
1-01-010828R	NORTH COLO PROP LTD	1776 SO JACKSON ST	DENVER	80210	CO	02	99	99	S	066 0W	03 0S	04		SW NW	6	- -57	200.0	33	20	.0	0	
1-01-010829R	NORTH COLO PROP LTD	1776 SO JACKSON ST	DENVER	80210	CO	02	99	99	S	066 0W	03 0S	04		SW NW	6	- -57	100.0	33	27	.0	0	
1-01-010830R	NORTH COLO PROP LTD	1776 SO JACKSON ST	DENVER	80210	CO	02	99	99	S	066 0W	03 0S	04		SW NW	6	- -57	100.0	33	21	.0	0	
1-01-010831R	NORTH COLO PROP LTD	1776 SO JACKSON ST	DENVER	80210	CO	02	99	99	S	066 0W	03 0S	04		SE NW	6	- -50	200.0	40	10	.0	0	
1-01-010832R	NORTH COLO PROP LTD	1776 SO JACKSON ST	DENVER	80210	CO	02	99	99	S	066 0W	03 0S	04		SW NW	6	- -57	100.0	33	29	.0	0	
1-01-029C[illegible]	REITHER ROBERT	RT 1 BOX 108	COMM CITY	80022	CO	02	99	99	S	066 0W	03 0S	04		NW SW	1	10-04-56	10.0	UNK	88	.0	0	
1-01-044[illegible]3	REITHER JOHN	R R 1 BOX 9[illegible]	COMMERCE CIT		CO	02	99	99	S	066 0W	03 0S	04		NE SW	1	09-29-54	20.0	55	34	.0	0	
1-01-005269	MAURER EARL	6300 PONTIAC	DERBY		CO	02	99	99	S	066 0W	03 0S	07		SE NE	1	03- -60	10.0	74	57	.0	0	
1-01-000078W	MOFFITT JOE C	1635 OAKLAND ST	AURORA 8		CO																	

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FILE CONTROL D-CT-PERMIT NUMBER	OWNER NAME/S	STREET ADDRESS	CITY	ZIP	ST	W D	N D	S B	P M	RANGE	TOWN SHIP	SEC	SEC LOCAT'N COORDINATES	QUARTER SECTIONS	USE	DATE	WELL YIELD	WELL DPTH	WATR LVEL	ANNUAL APPROP	IRR ACRS	GEOL AQUIFER
1-03-001866	KIRKEGAARD ARNOLD J	16475E 11TH AV	DENVER 8		CO	02	99	99	S	066 0W	04 0S	05		SW NE	1	08-25-58	15.0	551	240	.0	0	
1-03-002513	FURNBERTH SIGURD	16300E 12TH AV	AURORA		CO	02	99	99	S	066 0W	04 0S	05		NW NE	1	12-05-58	12.0	232	190	.0	0	
1-03-002676	PRICE EDWIN PRICE MARIAN	16025E 11TH AV 16025E 11TH AV	ALTURA ALTURA		CO CO	02	99	99	S	066 0W	04 0S	05		SE NW	1	01-30-59	2.0	110	40	.0	0	
1-03-003043	MERKOWITZ SKE	15490E COLFAX	DENVER 8		CO	02	99	99	S	066 0W	04 0S	05		NW NW	1	04-06-59	13.0	955	320	.0	0	
1-03-003218	SPEAR, DEAN E.	648 LAREDO ST.	AURORA	80011	CO	02	99	99	S	066 0W	04 0S	05	1120N,1050W	NW NW	1	05-22-59	8.0	570	205	.0	0	
1-03-003483P	AURORA PUB SCHOOLS		AURORA		CO	02	99	99	S	066 0W	04 0S	05		SE NW	6	08-01-62	40.0	1303	250	.0	0	
1-03-015968	TEST JOHN L.	1000 JEANETTE ST	AURORA		CO	02	99	99	S	066 0W	04 0S	05		NW SE	1	- -47	10.0	75	0	.0	0	
1-03-036376	BELLROSE HILDEGARD T BELLROSE URBAN H	333 S YOST ST 333 S YOST ST	AURORA AURORA		CO CO	02	99	99	S	066 0W	04 0S	05		NE NW	1	03-01-51	5.0	73	6	.0	0	
1-03-064432	BAILEY, KEITH	1220 LAREDO ST.	AURORA	80011	CO	02	99	99	S	066 0W	04 0S	05	1600N,2300E	SW NE	5	00-00-47	10.0	72		8.3	1	
1-03-000255	LUDVIGSEN K H	15800 E 12TH AVE	DENVER 8		CO	02	99	99	S	066 0W	04 0S	06		SE NE	1	08-27-57	15.0	175	80	.0	0	
1-03-001110	FANNING OSCAR	14290E COLFAX	AURORA		CO	02	99	99	S	066 0W	04 0S	06		NW NW	1	05-12-58	10.0	100	15	.0	0	
1-03-004411R	LUDVIGSEN K H	15800E 12TH AV	AURORA		CO	02	99	99	S	066 0W	04 0S	06		SE NE	1	12- -50	20.0	0	0	.0	0	
1-03-010186P	AURORA PUBLIC SCHOOLS	1085 PEORIA	AURORA		CO	02	99	99	S	066 0W	04 0S	06		SE NE	4	08-25-63	36.0	1298	100	.0	0	
1-03-012450	SNAPKA CHARLEY J	6 AVES CHAMBER RD	AURORA		CO	02	99	99	S	066 0W	04 0S	06		SE SE	1	07-24-62	5.0	70	25	.0	0	
1-03-014632	WALTERS JACK W	996 DEARBORN	AURORA		CO	02	99	99	S	066 0W	04 0S	06		NW SE	1	03-29-63	6.0	100	45	.0	0	
1-03-034895	BOLTON LEN	14460 E COLFAX AVE	AURORA		CO	02	99	99	S	066 0W	04 0S	06		NW NE	1	03-06-69	15.0	55	8	.0	0	
1-03-053737	GARCIA, JUAN F.	15667 E 13 AVE	AURORA		CO	02	99	99	S	066 0W	04 0S	06		NE NE	1	04-15-72	15.0	36	12	.0	0	
1-03-000219	BROWN JAMES E	345 NURSERY LA	AURORA		CO	02	99	99	S	066 0W	04 0S	07		NW NW	1	09-04-57	14.0	450	220	.0	0	
1-03-001196R	FLORENCE GARDENS WATER DISTRICT	1549 EMPORIA ST 1549 EMPORIA ST	AURORA AURORA		CO CO	02	99	99	S	066 0W	04 0S	07		NE SW	8	10- -53	80.0	1016	191	.0	0	
1-03-004421R	CAPE HAYWARD B	1136 YOST ST	AURORA B		CO	02	99	99	S	066 0W	04 0S	07		NE NW	6	09- -56	780.0	0	0	.0	0	
1-03-013361	BOHN JOHN	RT 3 BOX 416	DENVER		CO	02	99	99	S	066 0W	04 0S	07		SE NW	1	11-30-62	20.0	1101	170	.0	0	
1-03-017110	GARVIE, MRS GEORGE ANN	2526 CLAY	DENVER		CO	02	99	99	S	066 0W	04 0S	07		NW NE	1	08-30-63	16.0	430				

DATE OF UPDATE IS 08-07-84

**** B 16 ****

ICAE-R1, DIVISION OF WATER RESOURCES, GROUND WATER SECTION, MASTER EXTRACT LIST

FULL MASTER LIST BY LOCATION

FILE CONTROL D-CT-PERMIT NUMBER	OWNER NAME/S	STREET ADDRESS	CITY	ZIP	ST	W D	N D	S B	P M	RANGE	TOWN SHIP	SEC	SEC LOCAT'N COORDINATES	QUARTER SECTIONS	USE	DATE	WELL YIELD	WELL DPTH	WATR LVEL	ANNUAL APPROP	IRR ACRS	GEOL AQUIFER
1-03-017835F	BRESNAHAN, M. A. BRESNAHAN, C. A.	155 S. CHAMBERS RD 155 S. CHAMBERS RD	AURORA AURORA	80010 80010	CO CO	02	99	99	S	066 0W	04 0S	07	1450S,0150E	NE SE	0	07-05-50	675.0	20	0	200.0	90	
1-03-047770	SELLARS DONALD R	372 ZION ST	AURORA		CO	02	99	99	S	066 0W	04 0S	07		SW NW	1	09-13-71	.0	65	UNK	.0	0	
1-03-076320	CHASE, WILSON	145 S CHAMBERS RD	AURORA	80011	CO	02	99	99	S	066 0W	04 0S	07	1050S,0950E	SE SE	3	10-07-76	15.0	607	271	1.0	0	NO SBU
1-03-007770F	BRESNAHAN C A	115 S CHAMBERS RD	DENVER 8		CO	02	99	99	S	066 0W	04 0S	08		SW SW	4	09-30-57	80.0	1400	0	.0	0	
1-03-010741	FOOS J G	260 JEANETTE	DENVER 8		CO	02	99	99	S	066 0W	04 0S	08		NW SW	1	02-17-62	10.0	375	94	.0	0	
1-03-017833F	BRESNAHAN, M. A. BRESNAHAN, C. A.	155 S. CHAMBERS RD 155 S. CHAMBERS RD	AURORA AURORA	80010 80010	CO CO	02	99	99	S	066 0W	04 0S	08	0300S,1480W	SE SW	6	05-00-57	675.0	20	0	200.0	97	
1-03-017834F	BRESNAHAN, M A BRESNAHAN, C A	155 SO CHAMBERS RD 155 SO CHAMBERS RD	AURORA AURORA	80010 80010	CO CO	02	99	99	S	066 0W	04 0S	08	0450S,0650W	SW SW	6	05-00-57	675.0	20		200.0	97	
1-03-026301	HAMMONS DON P	RT 3 BOX 366A	AURORA		CO	02	99	99	S	066 0W	04 0S	08		SE NE	1	02-09-66	7.0	615	232	.0	0	
1-03-033138	EHALT GEORGE	275 REYNOLDS	AURORA		CO	02	99	99	S	066 0W	04 0S	08		SW NE	1	03-15-68	4525.9	520	UNK	.0	0	
1-03-033841	HAMMOS DON	16850 22ND AVE	AURORA		CO	02	99	99	S	066 0W	04 0S	08		SE NE	1	06-05-68	6.0	348	260	.0	0	
1-03-043638	WALLACE JAMES	260 LARADO	AURORA		CO	02	99	99	S	066 0W	04 0S	08		SE NE	1	11- -70	20.0	[illegible]	360	.0	0	
1-03-044512	ALLARD, TRAN P	1316 HAVANA	AURORA		CO	02	99	99	S	066 0W	04 0S	08		NE NW	1	02-28-71	10.0	317	300	.0	0	
1-03-049235	ADAMS FRANCES M ADAMS ROBERT L	275 REYNOLDS RD 275 REYNOLDS RD	AURORA AURORA		CO CO	02	99	99	S	066 0W	04 0S	08		SW NE	1	10-08-71	15.0	633	332	.0	0	
1-03-050542	SCHOONOVER, EDWIN	236 LAREDO	AURORA	80011	CO	02	99	99	S	066 0W	04 0S	08		SW NE	1	12-00-71		520	350			NO SBU
1-03-062735	CHASE, GISELA E CHASE, WILSON A	[illegible] E 4TH AVE [illegible] E 4TH AVE	AURORA AURORA	80010 80010	CO CO	02	99	99	S	066 0W	04 0S	08		NE NE	1	00-00-40	15.0	0	0	0	1	
1-03-068744	HAMMONS, DON	RT 3 BOX 366 A	AURORA	80011	CO	02	99	99	S	066 0W	04 0S	08	[illegible]	SE NE	1	07-21-75	10.0	535	240	1.0	1	NO SBU
1-03-189499	AURORA PUBLIC SCHOOLS	1085 PEORIA	AURORA	80011	CO	02	99	99	S	066 0W	04 0S	09	0170N,0420W	NW NW	6	10-01-75	75.0	1330	360	10.0	12	
1-03-016116R	COLO AIR NATL GUARD		DENVER 30		CO	02	99	99	S	066 0W	04 0S	10		NW NE	8	- -42	137.0	2186	307	.0	0	
1-03-016117R	COLORADO AIR NATIONAL GUARD	BUCKLEY A N G BASE	DENVER 30		CO	02	99	99	S	066 0W	04 0S	10		NE SW	8	- -42	110.0	2100	UNK	.0	0	
1-03-013445	CHAPPELL CHARLES W	P O BOX 3538	AURORA		CO	02	99	99	S	066 0W	04 0S	1[illegible]		SE SE	1	11-02-62	15.0	[illegible]	17	.0	0	
1-03-027284	HUBBARD H E	RT 3 BOX 767	AURORA		CO	02	99	99	S	066 0W	04 0S	11		SE SW	1	05-19-66	1.0	100	25	.0	0	

FILE CONTROL / PERMIT	OWNER NAME/S	STREET ADDRESS	CITY	ZIP	ST	P D	M D	D R	P M	RANGE	TOWNSHIP	SEC	SEC LOCAT'N COORDINATES	QUARTER SECTIONS	USE	DATE	WELL YIELD	WELL DPTH	WATE LVEL	ANNUAL APPROP	IRR. ACRS	GEOL AQUIFER
						08	99	99	S	066 0W	05 0S	35	0100S,0200E	SE SE	8	09-08-75	200.0	946	344	125.0		0
1-03-018831F	WELLEMA, W. EVERT	8250 SO TRAVOIS TRAIL	PARKER	80134	CO	08	99	99	S	066 0W	05 0S	35	0190S,0340E	SE SE	8	09-08-75	200.0	806	350	125.0		0
1-03-012090R	ALLEN EDNA F ALLEN HAROLD F	2935 S GILPIN ST 2935 S GILPIN ST	DENVER DENVER		CO CO	02	99	99	S	066 0W	04 0S	02		SE SE	6	03-04-49	350.0	43	21	.0		0
1-03-019337F	STONE, JOHN T	1016 ODESSA ST.	AURORA	80011	CO	02	99	99	S	066 0W	04 0S	C2	2253S,0080E	NE SE	6	04-07-71	10.0			.0		5
1-03-024245	MARTZ ANDY		AURORA		CO	02	99	99	S	066 0W	04 0S	02		SE SE	1	06-14-63	3.0	42	34	.0		U
1-03-041498	SCHMALL JOHN	885 ZION ST	AURORA		CO	02	99	99	S	066 0W	04 0S	02		NW SE	1	03-28-70	14.0	200	42	.0		0
1-03-042176	BUCKER, JACK	21458 E.9TH PL.	AURORA	80011	CO	02	99	99	S	066 0W	04 0S	02	1410S,2400E	NW SE	3	07-15-70	10.0	348	201	1.0		1 NO SBU
1-03-042177	PENK CHESTER	1465 QUINCE	DENVER		CO	02	99	99	S	066 0W	04 0S	02		NW SE	1	07-07-70	9.0	283	88	.0		0
1-03-043683	METCALFE W N	14100 E CEDAR AVE	AURORA		CO	02	99	99	S	066 0W	C4 0S	02		SE SE	1	06-21-71	8.0	220	100	.0		0
1-03-046082	WEST, CARL	1124 KENTON	AURORA	80010	CO	02	99	99	S	066 0W	04 0S	02	2 89S,1511E	NW SE	1	06-02-71	***** NO STAT RECORD *****					
1-03-046127	CLAY, KEITH L	991 OURAY	AURORA	80011	CO	02	99	99	S	066 0W	04 0S	02	2000S,2410E	NW SE	1	05-24-71	15.0	735	245	1.0		1 NO SBU
1-03-046128	MELTON, THOMAS S.	21200 E. 11TH	AURORA	80011	CO	02	99	99	S	06. 0W	04 0S	02	2300N,1100E	SW NE	1	05-19-71	15.0	700	180	1.0		1 NO SBU
1-03-048817	WARGA JOHN MRS	227 TROY ST	AURORA		CO	02	99	99	S	066 0W	04 0S	02		NW SE	1	09-20-71	7.0	300	62	.0		0
1-03-048818	SCHANTZ GLEN	515 EMPIRE	AURORA		CO	02	99	99	S	066 0W	04 0S	02	2373S,1720E	NW SE	1	08-31-71	12.0	743	223	1.0		0
1-03-048819	LEE, AUDREY D	21152 E 9TH PL	AURORA	80011	CO	02	99	99	S	066 0W	04 0S	02	1400N,1385E	SW NE	1	09-15-71	15.0	215		2.0		1
1-03-051777	THOMPSON, CARL	761 MOLINE ST	AURORA	80010	CO	02	99	99	S	066 0W	04 0S	02	2788N,1044E	NE SE	1	05-15-72	8.0	450	63	1.0		1
1-03-053823	MIGRO, RALPH M	1751 CLERMONT ST	DENVER	80220	CO	02	99	99	S	066 0W	04 0S	02		NE NW	1	05-01-74	10.0	240	81	1.0		3
1-03-073554	WISCHMEIER, VIRGIL M.	RT. 3 BOX 35	AURORA	80011	CO	02	99	99	S	066 0W	04 0S	02	1595S,1200E	NE SE	1	12-09-74	8.0	340	110	1.0		1 NO SBU
1-03-075083	SIMONT, CLARK	889 ODESSA	AURORA	80011	CO	02	99	99	S	066 0W	04 0S	02	1500S,1150E	NE SE	1	12-06-74	11.0	305	67	1.0		1
1-03-102765	EUBANKS, J P	965 PICADILLY RD	AURORA	80011	CO	02	99	99	S	066 0W	04 0S	02	1809S,0330E	NE SE	3	10-15-78	15.0	390	130	1.0		1
1-03-102790	GRAVLAND, ORDEAN J GRAVLAND, EVELYN R	21100 E 11TH AVE 21100 E 11TH AVE	AURORA AURORA	80011 80011	CO CO	02	99	99	S	066 0W	04 0S	02	2780N,1936E	NW SE	1	06-28-80	15.0	840	300	1.0		1
1-03-002615F	COLORADO DEPT OF HIGHWAYS	4201 E ARK AVE	DENVER		CO	02	99	99	S	066 0W	04 0S	03		NE NW	1	06-18-60	40.0	34	18			
1-03-005475F	CORE W F	3400 WADSWORTH	WHEATRIDGE		CO	02	99	99	S	066 0W	04 0S	03		NW NW	4	04-10-64	30.0	40	20	.0		0

DATE OF UPDATE IS 0 -07-84

**** M 15 ****

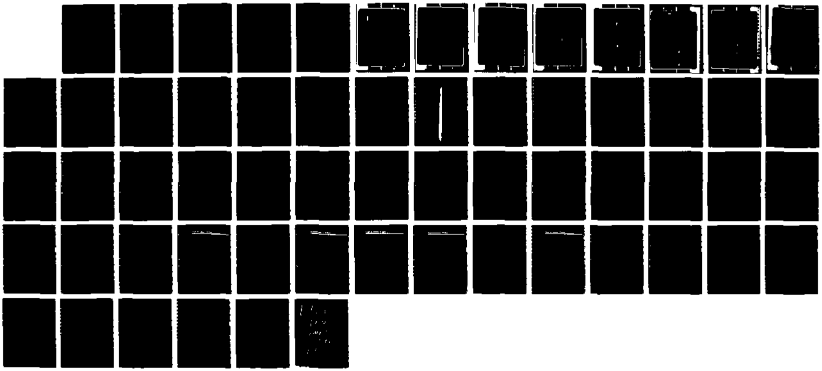
ICAE-R1, DIVISION OF WATER RESOURCES, GROUND WATER SECTION, MASTER EXTRACT LIST

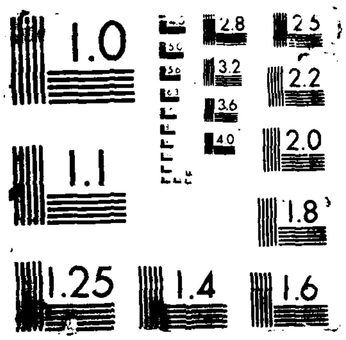
FULL MASTER LIST BY LOCATION

FILE CONTROL / C-CT-PERMIT	OWNER NAME/S	STREET ADDRESS	CITY	ZIP	ST	P D	M D	D R	P M	RANGE	TOWNSHIP	SEC	SEC LOCAT'N COORDINATES	QUARTER SECTIONS	USE	DATE	WELL YIELD	WELL DPTH	WATE LVEL	ANNUAL APPROP	IRR. ACRS	GEOL AQUIFER
1-03-016115R	COLO AIR NATL GUARD		DENVER	30	CO	02	99	99	S	066 0W	04 0S	03		SE SE	8	- -42	136.0	2184	300	.0		0
1-03-019710R	ACKARD WILLIAM C	1742 SHERMAN ST	DENVER		CO	02	99	99	S	066 0W	04 0S	03		NE NW	6	04-01-51	450.0	37	20	.0		0
1-03-020824R	ACKARD WILLIAM C	1742 SHERMAN ST	DENVER		CO	02	99	99	S	066 0W	04 0S	03		NW NE	6	03-01-55	250.0	33	20	.0		0
1-03-000170	FOX EDWARD J	1350 BUCKLEY RD	DENVER	8	CO	02	99	99	S	066 0W	04 0S	04		NW NW	1	08-10-57	10.0	561	0	.0		0
1-03-00017[illegible]	SULLIVAN, R	18460 E COLFAX AVE	AURORA	80011	CO	02	99	99	S	066 0W	04 0S	04	0795N,0115E	NE NE	1	08-16-57	22.0	560	235	1.0		1
1-03-004603	MURRAY, WM. A. MURRAY, JUNE R.	18011 E. 14 DRIVE 18011 E. 14 DRIVE	AURORA AURORA	80011 80011	CO CO	02	99	99	S	066 0W	04 0S	04	1450N,1300E	SE NE	1	10-05-59	15.0	50	9	.0		0
1-03-005192	CAVANAUGH F [illegible]	492 GALENA	DENVER	8	CO	02	99	99	S	066 0W	04 0S	04		SE SE	1	02-03-60	25.0	44	12	.0		0
1-03-007765F	AURORA WSTN ELC CORP	9523 E COLFAX	DENVER		CO	02	99	99	S	066 0W	04 0S	04		SE NE	8	09-24-57	210.0	45	0	.0		0
1-03-007769F	AURORA WSTN ELC CORP	9523 E COLFAX AV	AURORA		CO	02	99	99	S	066 0W	04 0S	04		SE NE	8	09-25-57	.0	47	0	.0		0
1-03 07[illegible]	DOBB M L	1125 S MADISON	DENVER	10	CO	02	99	99	S	066 0W	04 0S	04		NE NE	1	03- -61	15.0	41	35	.0		0
1-03-0[illegible]	ELLM C J	1250 [illegible] ST	AURORA		CO	02	99	99	S	066 0W	04 0S	04		SE NW	1	06-17-61	13.0	533	210	.0		0
1-03-01245[illegible]	ABRAHAMSEN M F	325 MOLINE ST	AURORA		CO	02	99	99	S	066 0W	04 0S	04		SE NW	1	08-08-62	25.0	562	295	.0		0
1-03-0196	LEACH RALPH M	1479 HUDSON	DENVER	20	CO	02	99	99	S	066 0W	04 0S	04		SE NE	1	04-22-64	15.0	50	20	.0		0
1-03-0[illegible]	RUSH EDWARD L	17150 E 13TH	AURORA		CO	02	99	99	S	066 0W	04 0S	04		SW NW	1	[illegible]7- -64	18.0	616	300	.0		0
1-03-02147	CITY OF AURORA PRKS DEPT	1470 SO HAVANA	AURORA	80012	CO	02	99	99	S	066 0W	04 0S	04	2590N,C1510E	SE NE	6	09-12-77	150.0	1350	383	42.0		70
1-03-022015	HAHN ARNOLD H	2333 IVY	DENVER		CO	02	99	99	S	066 0W	04 0S	04		NW SE	1	10-20-64	10.0	610	289	.0		0
1-03-02555[illegible]	HUNT KATHLEEN	[illegible] GENEVA	AURORA		CO	02	99	99	S	066 0W	04 0S	04		NE NE	1	10-15-65	20.0	45	16	.0		0
1-03-092174	LOMBARDI WILLIAM	405 OAKLAND	AURORA		CO	02	99	99	S	066 0W	04 0S	04		SE NW	1	09-22-67	25.0	570	320	.0		0
1-03-062023	CARREL, GARNET I (BARNETT)	17200 E 11TH AVE	AURORA	80010	CO	02	99	99	S	066 0W	04 0S	04		SW NW	1	09-01-52	15.0	[illegible]	0	.0		3
1-03-074888	WESTLAKE, DONALD J	1160 BUCKLEY RD	AURORA	80010	CO	02	99	99	S	066 0W	04 0S	04	1095N,C1170	SW NW	1	09-20-52	12.0	564		1.0		1
1-03-00531[illegible]	INGEBRITSON OLIVER	[illegible] E 12TH AV	AURORA		CO	02	99	99	S	066 0W	04 0S	05		SE NW	1	10-26-57	5.0	85	80	.0		0
1-03-000879	SMITH CHESTER A	1128 JEANETTE ST	ALTURA		CO	02	99	99	S	066 0W	04 0S	05		SE NW	1	04-02-58	5.0	200	190	.0		0
1-03-00[illegible]	HUDSON J C	97[illegible] JEANETTE ST	DENVER	8	CO	02	99	99	S	066 0W	[illegible]	[illegible]		NW SE	1	[illegible]-18-58	[illegible].0	566	235	.0		0

AD-A195 525 INSTALLATION RESTORATION PROGRAM (IRP) PHASE 2 CONFIRMATION/QUANTIFICATIO..(U) DAMES AND MOORE PARK RIDGE IL 21 MAR 86 F33615-83-D-4002 2/2

UNCLASSIFIED F/G 24/4 NL

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3.2
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1.6

APPENDIX D

FIELD RAW DATA AND SURVEY DATA

MERRICK

DAMES & MOORE
FEB 19 1985
PARK RIDGE IL

December 21, 1984
Ref: 257-5338

Mr. Steve Werner
Dames & Moore
1626 Cole Blvd.
Golden, Colorado 80401

Dear Steve:

Enclosed is a list of elevations for the wells at Buckley Air National Guard Base and Lowry Air Force Base. Photocopies of all field notes with sketches and ties to the wells and borings are also included.

It has been a pleasure to serve you on this project.

Please call us if you should have any questions on this matter, or require any further services.

Respectfully

Nelson O'Connor

Nelson O'Connor, P.L.S.
Project Manager

NO'C/cjw

Enclosures

December 21, 1984

Ref: 257-5338

WELL ELEVATIONS

Buckley Air National Guard Base

Number	Elevation	Note
MW 1	5549.85	Top of PVC
MW 1	5547.08	Ground
MW 2	5560.58	Top of PVC
MW 2	5558.14	Ground
MW 3	5520.59	Top of PVC
MW 3	5517.94	Ground
MW 4	5517.80	Top of PVC
MW 4	5515.37	Ground

Lowry Air Force Base

Number	Elevation	Note
MW 1	5412.53	Top of PVC
MW 1	5410.62	Ground
MW 2	5415.98	Top of PVC
MW 2	5414.29	Ground
MW 3	5432.24	Top of PVC
MW 3	5431.24	Ground
MW 4	5436.48	Top of PVC
MW 4	5434.84	Ground
MW 5	5384.22	Top of PVC
MW 5	5382.21	Ground

COLORADO REGISTERED PROFESSIONAL LAND SURVEYOR
NELSON L. O'CONNOR
22100

December 21, 1984

Ref: 257-5338

WELL ELEVATIONS

Buckley Air National Guard Base

Number	Elevation	Note
MW 1	5549.85	Top of PVC
MW 1	5547.08	Ground
MW 2	5560.58	Top of PVC
MW 2	5558.14	Ground
MW 3	5520.59	Top of PVC
MW 3	5517.94	Ground
MW 4	5517.80	Top of PVC
MW 4	5515.37	Ground

Lowry Air Force Base

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MW 1	5412.53	Top of PVC
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MW 2	5414.29	Ground
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MW 3	5431.24	Ground
MW 4	5436.48	Top of PVC
MW 4	5434.84	Ground
MW 5	5384.22	Top of PVC
MW 5	5382.21	Ground

COLORADO REGISTERED
NELSON L. O'CONNOR
22100
PROFESSIONAL LAND SURVEYOR

CAROL,
You'll find the
general DRILLING LOCATIONS
MAPPED ON VARIOUS SHEETS
THROUGHOUT THE MAP SET.

742/1

JOB # 257-5338 B-2

HORIZ. AND VERTICLE CONTROL
FOR TEST HOLES @ [redacted]
ANG BASE

12/17/84

CREW: III π BURGETT
π ø JACKSON

WILD T-1 A-25
WILD NA-1 B-28
TOPCON DMC-2 C-15

20°F CLEAR

12/17/84
CONT

942/2

SW CORNER OF CONC. BASE OF
THE BORE SITE TOWER
ELEV. PROVIDED BY DAMES & MOORE

STA	BS	HI	FS	ELEV	
BM	0.83	40.78		5539.949	
TP1			[illegible]	29.59	
⊼	0.16	29.25			
TP2			10.01	19.74	
⊼	1.52	21.26			
TP3			8.57	12.69	
⊼	9.05	21.74			
MW-4			3.94	17.80	TOP OF PVC
MW-4			6.37	15.37	GRD
MW-3			1.15	20.59	TOP OF PVC
MW-3			3.80	17.94	GRD
TP4			0.41	21.33	
⊼	0.98	22.31			
TP5			0.75	21.56	
⊼	11.53	33.09			
TP6			0.53	32.56	
⊼	11.14	43.70			
TP7			1.00	42.70	
⊼	9.98	52.68			
MW-1			2.83	49.85	TOP OF PVC
MW-1			5.60	47.08	GRD
TP8			0.09	52.59	
⊼	8.90	61.49			
MW-2			0.91	60.58	TOP OF PVC
MW-2			3.35	58.14	GRD

STA	BS	HI	FS	ELEV		
		6149				
TP9			11.45	50.04		
⊼	1.04	51.08				
TP10			6.11	44.97		
⊼	3.80	48.77				
BM			8.82	39.95	5539.95	SAME AS Pg 2

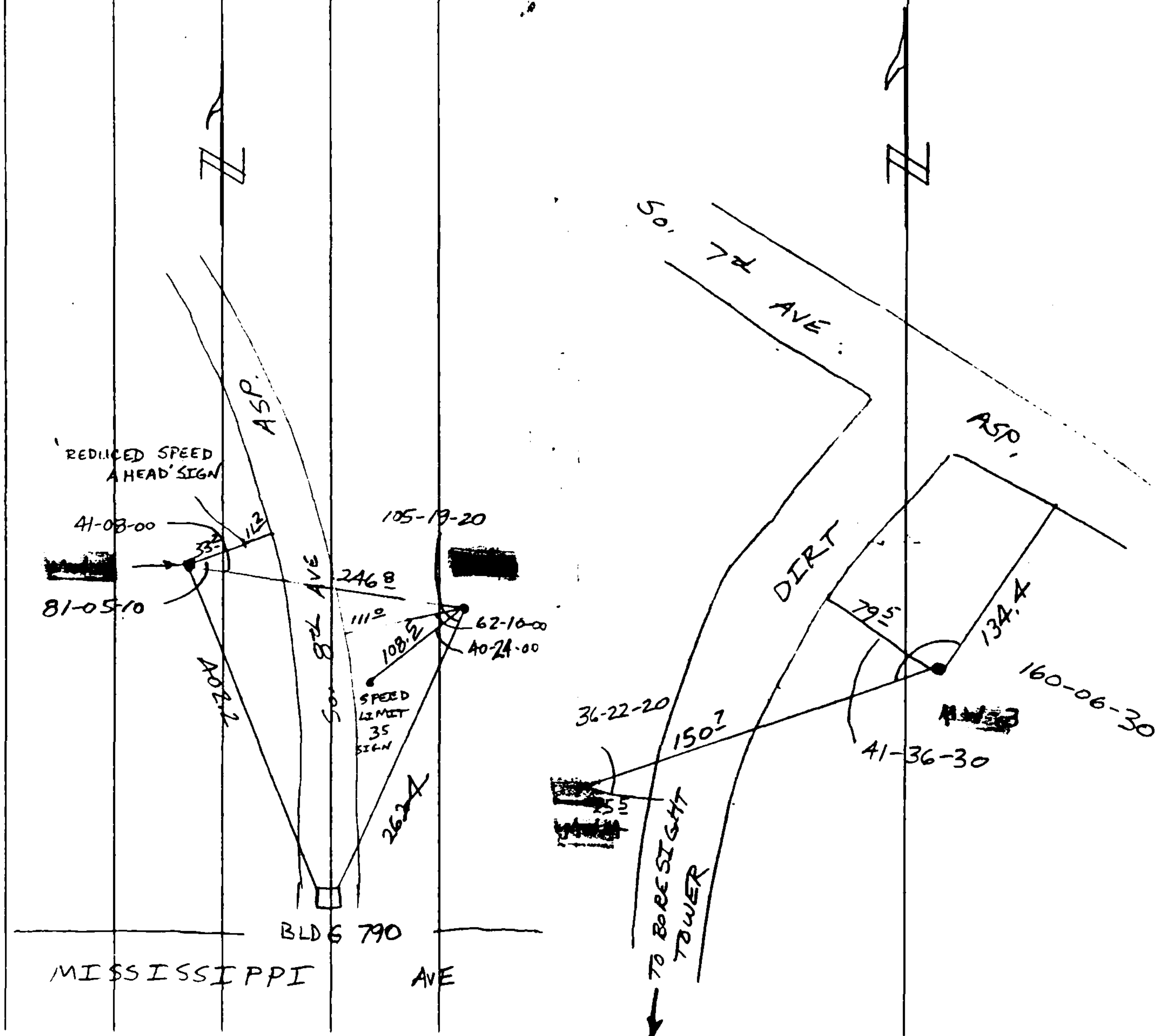
12/17/84
CONT

942/3

WELL LOCATIONS

12/18/84
CONT

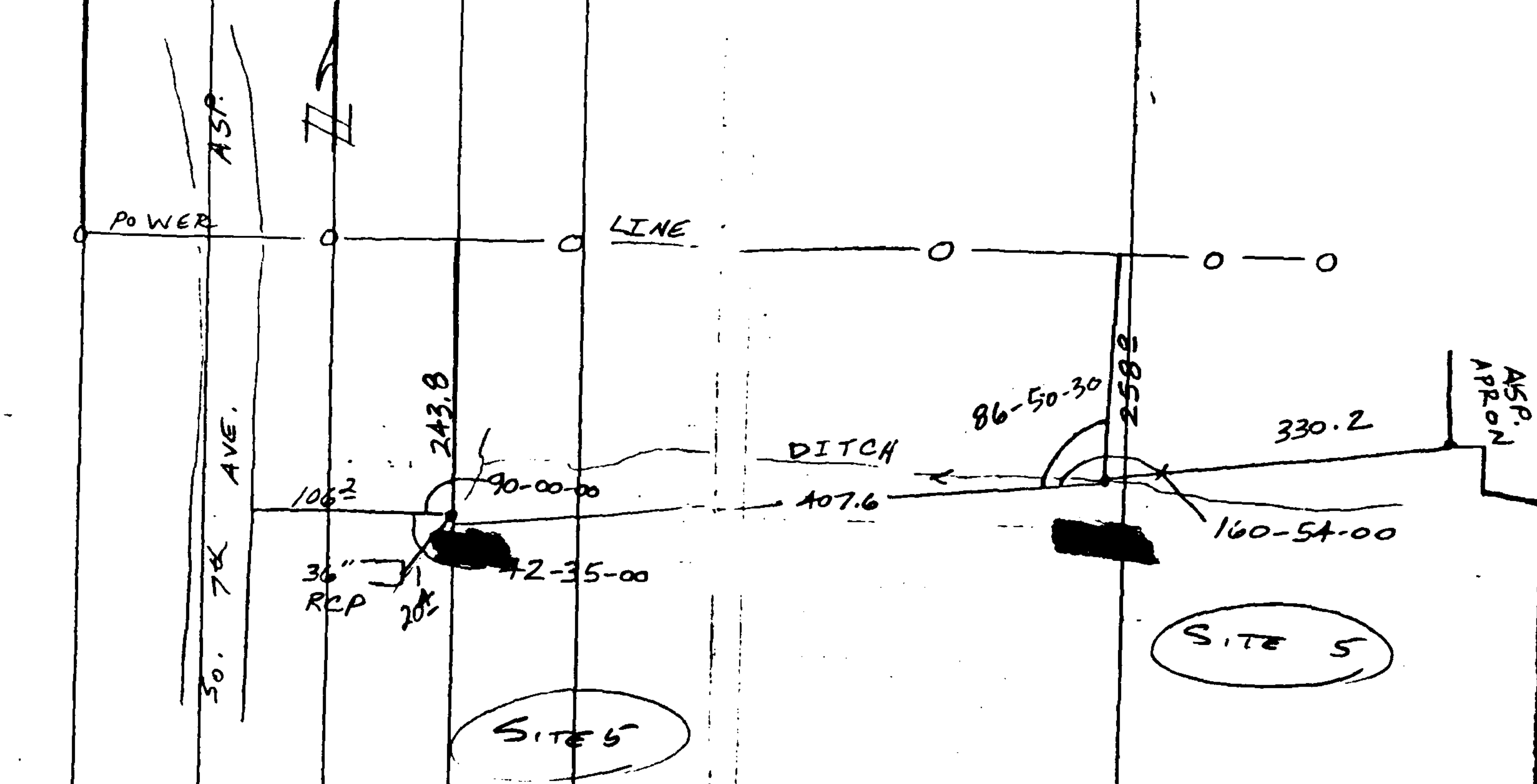
942/4

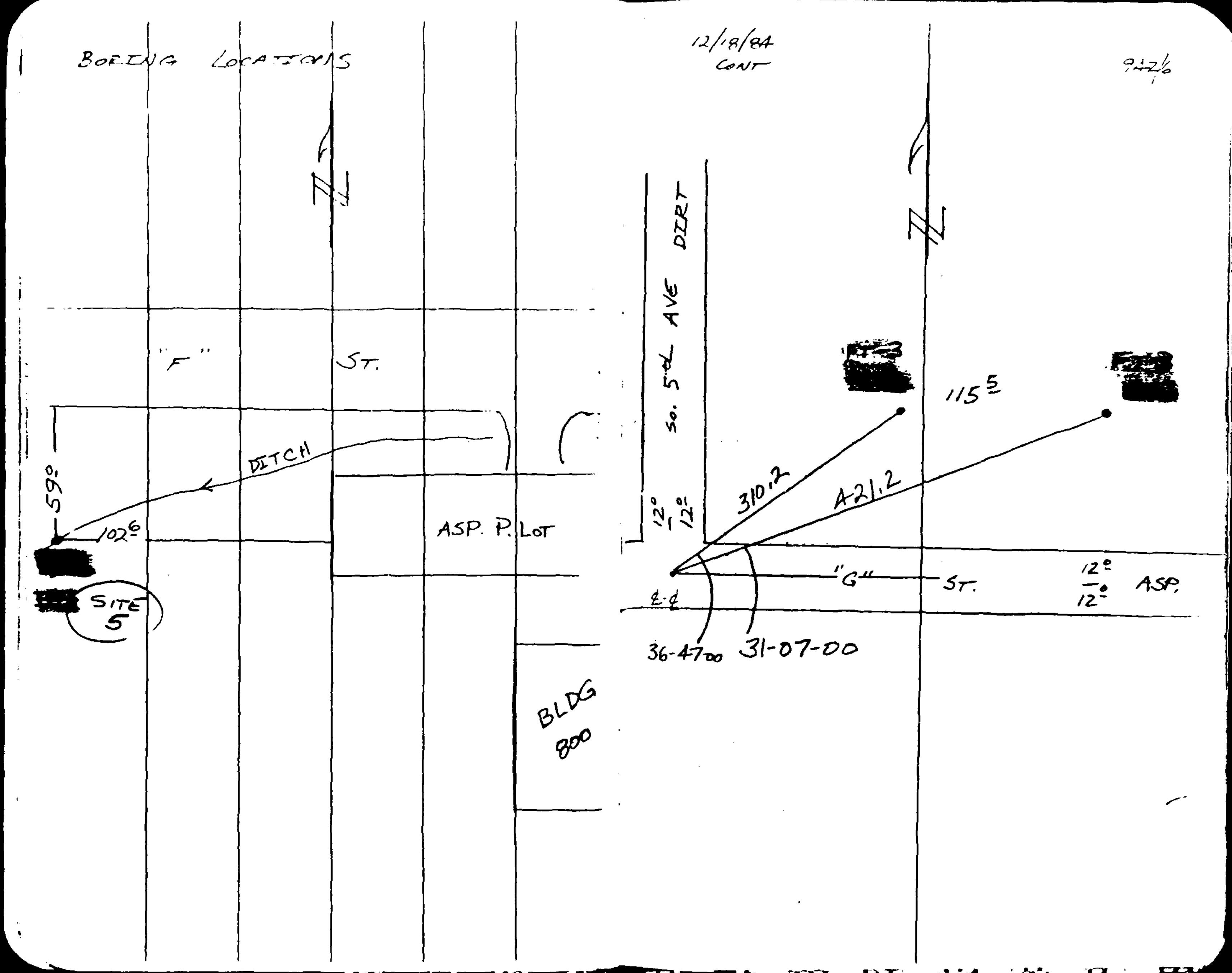


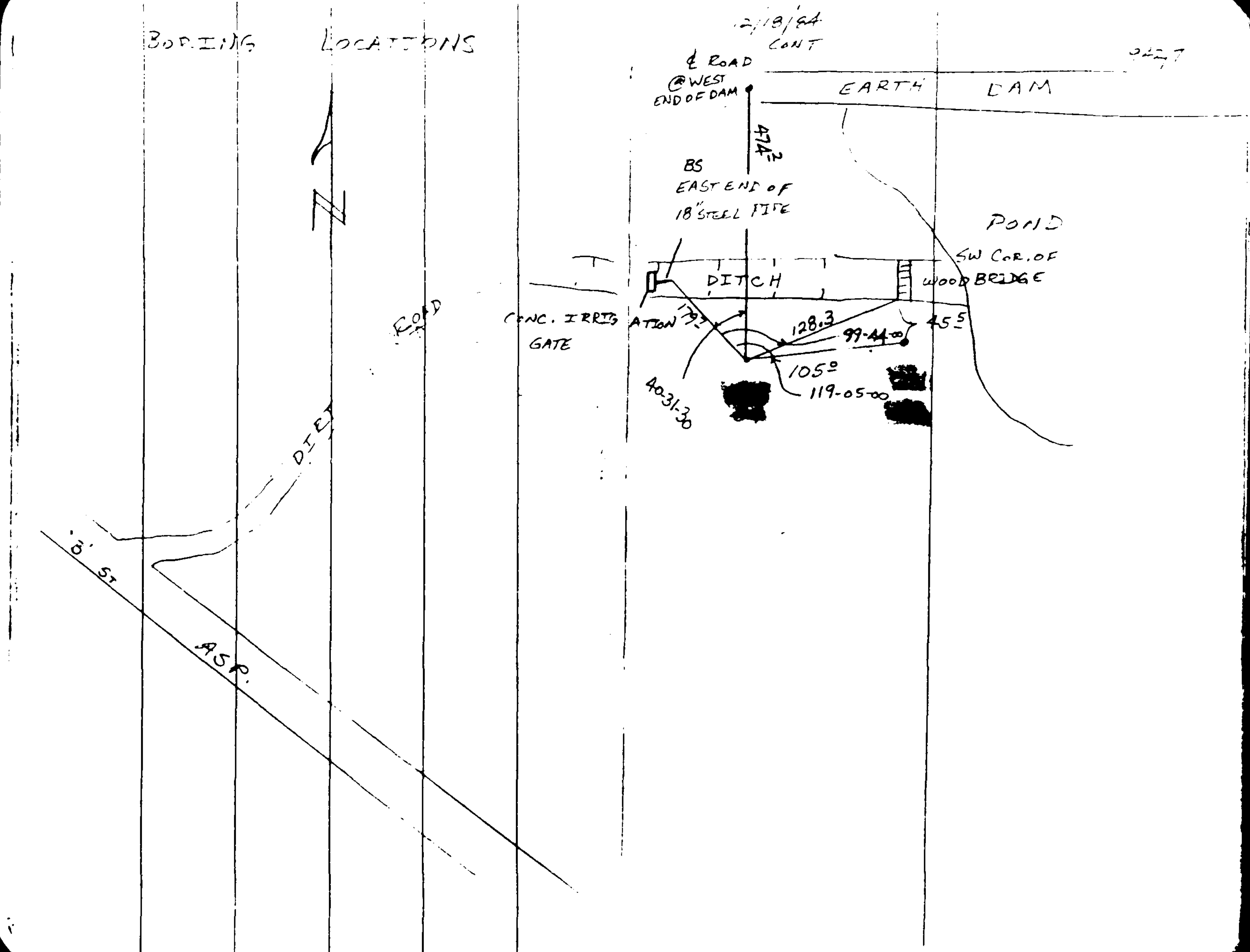
BORING LOCATIONS

12/18/84
CONT

942/5



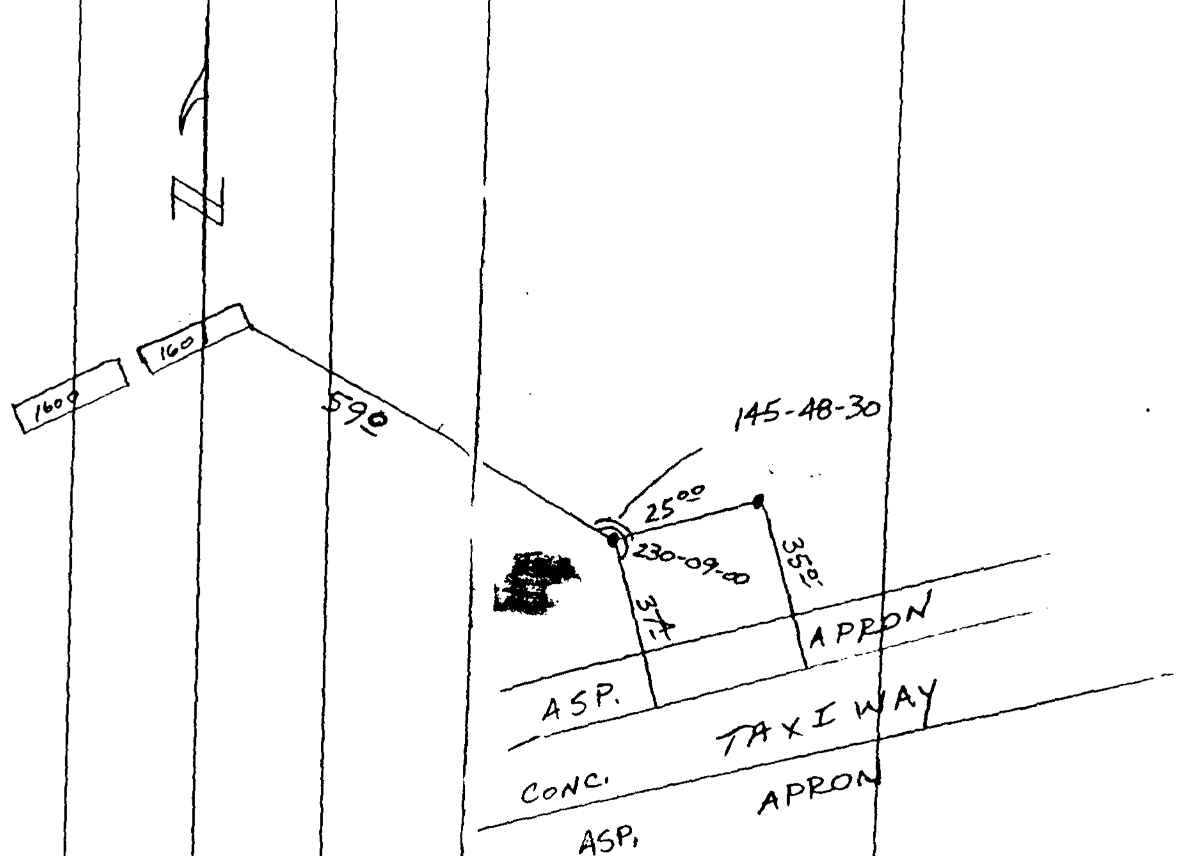

BORING LOCATIONS
12/18/84
CONT
"F" ST.
DITCH
59°
102.6
SITE 5
ASP. P. LOT
BLDG 800
SO. 5th AVE DIRT
12°
12°
310.2
A21.2
115.5
"G" ST.
12°
12°
ASP.
36-47-00
31-07-00


BORING LOCATIONS
12/18/84
CONT
9427
℄ ROAD
@ WEST
END OF DAM
EARTH DAM
474.2
BS
EAST END OF
18" STEEL PIPE
POND
SW COR. OF
WOOD BRIDGE
DITCH
ROAD
CONC. IRRIGATION
GATE
179.7
128.3
99-44-00
45.5
105°
119-05-00
40-31-30
DITCH
"B" ST
ASP.

BORING LOCATIONS

12/18/84
CONT

9A2/8



APPENDIX E

FIELD AND LABORATORY QUALITY CONTROL PROGRAMS

FIELD AND LABORATORY QUALITY CONTROL PROGRAMS

FIELD INVESTIGATION QUALITY CONTROL PROGRAM

Quality control of field activities consists of following established procedures during the conduct of the work. In those cases that require the drilling of test borings, installation of piezometers or monitor wells, and taking of soil and water samples, the procedures include the preparation of records to document the compliance with these procedures. These field records include boring logs, monitor well installation records, daily field memoranda, sample shipment and test instruction forms for soil sample testing, and chain-of-custody records for all soil and water samples intended for chemical analyses. The nature of water sample tests was established in advance so that plans could be made to ship samples in an appropriate and timely manner.

The pH and specific conductivity meters used for field water quality measurements were calibrated with known standards immediately before the measurements were made. The HNU photoionization detector and explosimeter used to monitor vapors generated while drilling have internal calibration routines that were followed when the meters were turned on. A detailed description of sampling procedures is located in Section III.

LABORATORY QUALITY CONTROL PROGRAM

UBTL is an accredited laboratory of the American Industrial Hygiene (AIHA) Association (No. 17) and, as such, participates in an extensive interlaboratory proficiency analytical testing program sponsored by the National Institute for Occupational Safety and Health (NIOSH). In addition, UBTL is currently licensed by the Center for Disease Control (CDC) to perform chemical and clinical analyses of biological specimens and is State of Utah/USEPA approved for environmental analyses. The comprehensive internal quality control program at UBTL is detailed as follows.

Introduction

UBTL has implemented an effective system for Quality Control (QC). Procedures that are employed include:

1. Services of a full-time Quality Control/Quality Assurance Section;
2. Preparation of internal quality control samples;
3. Collection and evaluation of quality control data;
4. Generation of quality control charts, and
5. Instrument calibration and maintenance.

Sample Analyses

At least one blank sample and one reagent blank are included with each set of analyses and processed through the complete analytical procedure in order to detect any contamination in either collection media or reagents. In addition, duplicate analyses are accomplished on a minimum of 10 percent of all samples submitted from the field. Internal quality control samples, generated in the laboratory and containing known quantities of specified analyte(s), are run at the rate of 10 percent of the total field sample workload. At the completion of the analysis of a sample set, each chemist calculates his results and reports the results on the Analytical Report Form. Results for replicated samples and internal quality control samples are reported on the computer-generated Quality Control Data Sheet. Before the results are submitted to the Group Leader, another peer chemist analyst is assigned to check results for possible errors in the calculations. He must approve results reported on both the quality control sheet and the sample sheet. The Group Leader, after his evaluation of the data, gives the report sheets to the Quality Assurance Specialist (QAS) for his evaluation and implementation of any required action.

Specific steps are followed when any one QC sample result is determined to be out of control in connection with the analysis of a field sample set. QC charts with adjusted control limits of $\pm$ 3 standard deviations will generally be used to determine whether a result is out of control. If QC results are in control, the QAS signs off the report. It is then reviewed by the Section Head for accuracy of the results. Upon final approval of the reports by the QAS and the Section Head, the reports are sent to the sponsor.

The paperwork containing the raw data for a sample set (i.e., chart paper, computer readouts, paper tapes, calibration curves, tables of data, etc.) is collected and placed in an $8\frac{1}{2}$-inch by 11-inch envelope that has been labeled with sample numbers, analyst, date, and other pertinent information. The envelopes are filed by laboratory number for possible future reference and data retrieval. Raw data for each sample analysis are therefore readily available, if needed.

Quality Control Sample Data Analysis

A record of the preparation of internal QC samples is detailed in the QC log book maintained by the QAS. As appropriate, a set of QC samples is distributed to the chemist along with each sample set at an average rate of at least 10 percent of the submitted samples. The analyses and data evaluations are performed for these QC samples, along with the submitted samples, and results are tabulated on the computer-generated Quality Control Data Sheet. At least duplicate results are reported for each internal QC sample.

QC charts are generated for each analyte through the analysis of QC sample results. Each result is divided by the theoretical value to standardize results so that data from all concentrations can be directly compared for accuracy and precision. When a control data set of N sample results has been accumulated, the following statistics are calculated: mean percent recovery, replicate standard deviation, and set standard deviation. These statistics are then used to determine accuracy and precision QC limits.

The control data set is updated after evaluation of 20 successive QC samples and includes data on the 50 most recent results. Any control sample analysis that is beyond accuracy or precision limits is not used in the subsequent determination of new limits.

External Quality Control Programs

In addition to internally generated QC data, other information concerning QC is provided by the participation of UBTL in four interlaboratory QC programs: NIOSH Proficiency Analytical Testing (PAT) Program; two CDC Blood Lead QC Programs; and State of Utah Environmental Quality Control Program. The PAT Program and the CDC Blood Lead Programs involve the participation of more than 100 laboratories on a nationwide basis. The PAT Program addresses the analysis of filter samples for lead, cadmium, zinc, free silica, and asbestos and the analysis of charcoal tubes for various organic solvents.

Laboratory Data Reduction

A significant fraction of the Chemistry Department's work involves data processing. Mathematical models, based upon analysis of standard solutions or samples, are generated in order to determine the quantity of analyte present in the samples. Considerable time and effort are saved by the utilization of automated data processing procedures. Data processing by the computer can include, for example, calculations, generation of standard calibration curves, mathematical modeling of standard curves, statistical analyses, and the generation of hard copy output. Advantages intrinsic to the use of an automated system include more accurate calculations, immediate and accurate generation of data plots, fewer transcription errors, and no calculation errors after programs have been verified and documented. In general, the types of data that are processed are those derived from the following techniques: atomic absorption and flame emission spectroscopy, gas and liquid chromatography, optical absorbance spectrophotometry, specific ion electrode, fluorescence spectroscopy, and wet chemistry determinations. Similar functions are employed for QC data. In addition, the data system is utilized to store QC data, provide statistical analyses, and generate and update QC charts.

The advantage of the provision for statistical analyses and the production of QC charts by automation is that the charts may be easily updated with minimal effort. QC data and any required action may, therefore, be provided on a daily basis.

Reporting Procedures

The analytical data are reported to the sponsor at the completion of each sample set. The report includes the following items:

1. A memorandum describing the sample set; the condition and appearance (i.e., homogeneity, integrity, etc.) of the samples upon receipt at UBTL; the method, equipment, and technique used in the determination; any interferences that were observed; and any unusual circumstances that may have occurred during the analysis. [The limit(s) of detection are also reported.]

2. UBTL Analytical Report Form, including field ID number, laboratory ID number, identification of the analytes, results of each determination, limit(s) of detection, and comments.

3. Other items, such as copies of strip chart recorder output, computer printout sheets, and other raw data (to be included as required).

Instrumentation

Each major equipment item at the UBTL Chemistry Department undergoes a routine preventive maintenance check on a regular schedule. This check is accomplished by a trained engineer. In addition, performance checks are made by the analyst prior to the analysis of each set of samples. This involves the analysis of one or more standards and a comparison of the values obtained with previous results and conditions. This information is recorded in an instrumentation log.

When an instrument or apparatus malfunctions and the problem is not readily corrected, the appropriate Section Head is notified. If it is determined that a visit by the service representative is required, a service call is scheduled and the QAS is notified. Action by the service representative is recorded by the QAS in the Instrument Maintenance Log, and the appropriate customer field and service order forms are filed, by instrument, in the Instrument Maintenance Log Supplement File. In an effort to monitor and maintain instrument specifications, logs for each of the AA spectrophotometers, the gas chromatographs (GC), the X-ray defractometer (X-ray), and the mass spectrometers (MS) have been provided for the analytical chemists' use each time an analysis is performed. The AA instrumentation logs

contain entries for date, analyst, lamp number (if more than one lamp is available), standard concentration (recommended in manual), reading in milliabsorbence units, and a column for when instrumental parameters differ from the recommended conditions listed in the manual. The GC, X-ray, and MS logs contain entries for date, time, analyst, set identification number, and comments on parameters or performance.

Training

UBTL has established a continuing program of training of current personnel with respect to QC procedures. In addition, an intensive program for the training of recently recruited personnel in both analytical methods and techniques and QC policies has been implemented. It is the responsibility of the QAS and the Laboratory Director to train all laboratory personnel.

Results of the Laboratory QC Program

The results of the QC analyses for soil and ground water samples are presented in Appendix G, Analytical Data.

Soil Analyses

The laboratory QC program for soils, presented in Appendix G, included duplicate and spiked samples for phenolics, TOC, TOX, EP toxic metals, endrin, lindane, methoxychlor, toxaphene, 2,4-D, 2,4,5-TP (Silvex), 2,4,5-T, and p,p'-DDT. Recoveries of spiked samples were good except that for lead, which was 3 percent. A matrix effect is suspected. A matrix effect occurs when the lead is not liberated completely during the analysis and, therefore, the measured values are lower than expected in the spike analyses. Other parameters ranged in recovery from 52 percent (TOX - interference effect) to 130 percent. Duplicate analyses for the above listed parameters plus moisture content were also acceptable.

Ground Water Analyses

The laboratory QC program for ground water samples, presented in Appendix G, included analyses for duplicate and spiked samples for cadmium, chromium, lead, nickel, silver, phenolics, TDS, TOC, TOX, aldrin, p,p'-DDT, dieldrin, endrin, heptachlor, lindane, 2,4-D, 2,4,5-TP (Silvex), and 2,4,5-T. Recoveries ranged from 75.3 percent (nickel) to 132 percent (p,p'-DDT). The only unacceptable value outside this range was 7 percent for lead, and a matrix effect is suspected. The duplicate analyses were acceptable.

[usaf-app/qc]

APPENDIX F

CHAIN-OF-CUSTODY FORMS

DAMES & MOORE CHAIN-OF-CUSTODY RECORD

Sample Source & Client: Buckley AFB

Project Title: Buckley IRP

Job No. 8016 215

Field Personnel (Signature): SLw

Date	Time	Sample I.D. No.	Sample Type	No. of Containers	Sampling Site	Remarks
10/24	1600	#1	Soil	1	MW-B3	
		#2				
		#3				
		#4				
		#5				
		#6				
		#7				
[redacted]						

Relinquished by: (Signature)	Date	Time	Received by: (Signature)	Date	Time	Relinquished by: (Signature)	Date	Time	Received by: (Signature)	Date	Time
[signature]	10/24	1600							A. Bregman	10/25/91	11:00 AM
Relinquished by: (Signature)	Date	Time	Received by: (Signature)	Date	Time	Relinquished by: (Signature)	Date	Time	Received by: (Signature)	Date	Time
Relinquished by: (Signature)	Date	Time	Received by: (Signature)	Date	Time	Relinquished by: (Signature)	Date	Time	Received by: (Signature)	Date	Time

DAMES & MOORE CHAIN-OF-CUSTODY RECORD

Sample Source & Client Bukley AFB

Project Title IRP

Job No. 01062-15

Field Personnel (Signature) [illegible]

Date	Time	Sample I.D. No.	Sample Type	No. of Containers	Sampling Site	Remarks
10/25	1500	#1	Soil	1	Site 1 MW4	
		#2				
		#3				
		#4				
		#5				
		#6				
		#7				

Relinquished by: (Signature)	Date	Time	Received by: (Signature)	Date	Time	Relinquished by: (Signature)	Date	Time	Received by: (Signature)	Date	Time
[illegible]	10/25	1500							[illegible]	11/1/84	1:00 PM
Relinquished by: (Signature)	Date	Time	Received by: (Signature)	Date	Time	Relinquished by: (Signature)	Date	Time	Received by: (Signature)	Date	Time
Relinquished by: (Signature)	Date	Time	Received by: (Signature)	Date	Time	Relinquished by: (Signature)	Date	Time	Received by: (Signature)	Date	Time

DAMES & MOORE CHAIN-OF-CUSTODY RECORD

Sample Source & Client: Buckley ANGB

Project Title: IRP

Job No. 0/016-215

Field Personnel (Signature): [illegible]

Date	Time	Sample I.D. No.	Sample Type	No. of Containers	Sampling Site	Remarks
10/26	1100	MW1-#1	Soil	1	Site 1.	Analyze
		MW1-#2				Store
		MW1-#3				Store
		MW2-#1				Analyze
		MW2-#2				Store
		MW2-#3				Store
		Drum Buckley	Drum cuttings	1		Test for EP toxicity ~~ti~~
						ignitability

Shipped UPS.

Relinquished by: (Signature)	Date	Time	Received by: (Signature)	Date	Time	Relinquished by: (Signature)	Date	Time	Received by: (Signature)	Date	Time
[illegible]	11/7	4/00							[illegible]	11/8/84	10:00AM
Relinquished by: (Signature)	Date	Time	Received by: (Signature)	Date	Time	Relinquished by: (Signature)	Date	Time	Received by: (Signature)	Date	Time
Relinquished by: (Signature)	Date	Time	Received by: (Signature)	Date	Time	Relinquished by: (Signature)	Date	Time	Received by: (Signature)	Date	Time

CHAIN-OF-CUSTODY RECORD

SAMPLER'S NAME: S. Warner **SAMPLING LOCATION:** Buckley [illegible]

COMPANY: Dames + Moore **TYPE OF SAMPLES:** Soil

MONITOR WELL NUMBER	DATE	TIME	NUMBER OF CONTAINERS	CONTAINER IDENTIFICATION NUMBER
FT1 B-1	10/27		6	#1 #2 #3 #4 #5 #6
FT1 B-2	10/29		6	#1 #2 #3 #4 #5 #6
Site 5 B-3	10/27		2	#5 #6

DATE	TIME	RELINQUISHED BY (SIGNATURE)	RECEIVED BY (SIGNATURE)
10/30	1500	S. Warner	
11/1/84	1:00 p.m.		AB [illegible]

METHOD OF SHIPMENT	DISPATCHED BY (SIGNATURE)
Airborne Express	S. Warner
RECEIVED AT ANALYTICAL LABORATORY BY (SIGNATURE) → → →	AB [illegible]

*One copy of this form should be kept on file at the plant. The other should accompany the samples to the laboratory. Each time the samples pass from the possession of one person to another, this form should be signed in the appropriate spaces.

CHAIN-OF-CUSTODY RECORD

SAMPLER'S NAME: Silverman **SAMPLING LOCATION:** Buckley A

COMPANY: Dames + Moore **TYPE OF SAMPLES:** Soil

Boring ~~MONITOR WELL NUMBER~~	DATE	TIME	NUMBER OF CONTAINERS	CONTAINER IDENTIFICATION NUMBER
FT3 B-1	10/29		6	#1 #2 #3 #4 #5 #6
FT3 B-2	10/29		6	#1 #2 #3 #4 #5 #6
Site 5 B-1	10/29		2	#1 #2

DATE	TIME	RELINQUISHED BY (SIGNATURE)	RECEIVED BY (SIGNATURE)
10/30	1500	Silverman	
11/1/94	1:00 Pm		A B Torgerson

METHOD OF SHIPMENT	DISPATCHED BY (SIGNATURE)
Airborne Express	
RECEIVED AT ANALYTICAL LABORATORY BY (SIGNATURE) → → →	A B Torgerson

*One copy of this form should be kept on file at the plant. The other should accompany the samples to the laboratory. Each time the samples pass from the possession of one person to another, this form should be signed in the appropriate ...

CHAIN-OF-CUSTODY RECORD

SAMPLER'S NAME: S. Werner **SAMPLING LOCATION:** Berkeley A[illegible]

COMPANY: Dames & Moore **TYPE OF SAMPLES:** Soil

MONITOR WELL NUMBER	DATE	TIME	NUMBER OF CONTAINERS	CONTAINER IDENTIFICATION NUMBER
site 5 B-1	10/29		4	#3 #4 #5 #6
site 5 B-2	10/29		6	#1 #2 #3 #4 #5 #6
site 5 B-3	10/29		4	#1 #2 #3 #4

DATE	TIME	RELINQUISHED BY (SIGNATURE)	RECEIVED BY (SIGNATURE)
10/30	1500	[signature]	
11/1/84	1:00 PM		[signature]

METHOD OF SHIPMENT	DISPATCHED BY (SIGNATURE)
Airborne Express	
RECEIVED AT ANALYTICAL LABORATORY BY (SIGNATURE) → → →	[signature]

*One copy of this form should be kept on file at the plant. The other should accompany the samples to the laboratory. Each time the samples pass from the possession of one person to another, this form should be signed in the appropriate spaces.

CHAIN-OF-CUSTODY RECORD

SAMPLER'S NAME: Silikrac **SAMPLING LOCATION:** [illegible]

COMPANY: Dames + Moore **TYPE OF SAMPLES:** Soil

MONITOR WELL NUMBER	DATE	TIME	NUMBER OF CONTAINERS	CONTAINER IDENTIFICATION NUMBER
FT2-B1	10/30		6	#1 #2 #3 #4 #5 #6
FT2-B2	10/30		6	#1 #2 #3 #4 #5 #6

DATE	TIME	RELINQUISHED BY (SIGNATURE)	RECEIVED BY (SIGNATURE)
10/30	1500	[signature]	
11/1/84	1:00 p.m		[signature]

METHOD OF SHIPMENT	DISPATCHED BY (SIGNATURE)
Air Borne Express	
RECEIVED AT ANALYTICAL LABORATORY BY (SIGNATURE) → → →	[signature]

*One copy of this form should be kept on file at the plant. The other should accompany the samples to the laboratory. Each time the samples pass from the possession of one person to another, this form should be signed in the appropriate spaces.

DAMES & MOORE CHAIN-OF-CUSTODY RECORD

Sample Source & Client: Buckley ANGB

Project Title: IRP

Job No. 01016 215

Field Personnel (Signature): [illegible]

Date	Time	Sample I.D. No.	Sample Type	No. of Containers	Sampling Site	Remarks
11/6	1100	Site 1 MW4	TOC	(4)	Site 1 MW4	Site 1 MW4 -
"	"	"	TOX	4	"	PH 6.8
"	"	"	Phenols	4	"	Cond. 2200 UHMS
"	"	"	TDS	4	"	temp 12.0°C
"	"	"	Metals	4	"	Volume bailed 30 gals
"	"	"	Pest	4	"	Depth 12.3'
"	"	"	Herb	4	"	
		~~[illegible]~~				
						Shipped Fed Exp.

Relinquished by: (Signature)	Date	Time	Received by: (Signature)	Date	Time	Relinquished by: (Signature)	Date	Time	Received by: (Signature)	Date	Time
[illegible]	11/6	1800							AB Torgerson	11/7/84	10:00 AM
Relinquished by: (Signature)	Date	Time	Received by: (Signature)	Date	Time	Relinquished by: (Signature)	Date	Time	Received by: (Signature)	Date	Time
Relinquished by: (Signature)	Date	Time	Received by: (Signature)	Date	Time	Relinquished by: (Signature)	Date	Time	Received by: (Signature)	Date	Time

DAMES & MOORE CHAIN-OF-CUSTODY RECORD

Sample Source & Client: Buckley ANGB

Project Title: TRP

Job No. 006-215

Field Personnel (Signature): [signature]

Date	Time	Sample I.D. No.	Sample Type	No. of Containers	Sampling Site	Remarks
11/6	1200	MW3 site1	TOC	1	Site1 MW3	site 1 mw 3-
"	"	"	TOX	1	"	pH 6.8
"	"	"	Phenols	1	"	Cond 2300
"	"	"	TDS	1	"	Temp 13.0°C
"	"	"	Metals	1	"	Volume bailed 30 gals
"	"	"	Pest	1	"	depth 14.1'
"	"	"	Herb	1	"	
	1400	site1 MW1		1	site1 MW1	Site 1 MW1
	"			1	"	Shipped Fed. Exp
"	"			1	"	Ph 6.9
	"			1	"	Cond 3400 uMhos
	"			1	"	Temp 13°C
	"			1	"	Volume bailed 40 gals
	"			1	"	depth 23.6'
	"					

Relinquished by: (Signature)	Date	Time	Received by: (Signature)	Date	Time	Relinquished by: (Signature)	Date	Time	Received by: (Signature)	Date	Time
[signature]	11/6	1800							[signature] A. Jorgensen	11/7/94	10:00 am
Relinquished by: (Signature)	Date	Time	Received by: (Signature)	Date	Time	Relinquished by: (Signature)	Date	Time	Received by: (Signature)	Date	Time
Relinquished by: (Signature)	Date	Time	Received by: (Signature)	Date	Time	Relinquished by: (Signature)	Date	Time	Received by: (Signature)	Date	Time

APPENDIX G

ANALYTICAL DATA

UBTL QUALITY CONTROL REPORT
Buckley ANGB - Soil Analyses (1)

Parameter	Method	Units	Detection Limit	Spiked Sample	Initial Value	Spike Conc.	Percent Recovered	Split Sample	First Value	Second Value	Method Blank
% Moisture	160.3(2)	%	1					MW3 #3 5-6.5'	.9	.9	
Phenolics	420.2(2)	µg/g	1.	MW3 #3 5-6.5'	46.1	99	89	MW3 #3 5-6.5'	134.1	133.3	*
TOC	415.1(2)	µg/g	5.	MW3 #3 5-6.5'	2.4	2.	117.2	MW3 #3 5-6.5'	2527	2272	*
TOX	9020(3)	µg/g	5.	MW3 #3 5-6.5'	*	18	52.(8)	MW3 #3 5-6.5'	*	*	*
Arsenic	206.2(2)(7)	mg/L	0.01	Drum	*	.04762	99.9	Drum	*	*	*
Barium	208.1(2)(7)	mg/L	0.1	Drum	*	0.47619	110.	Drum	*	*	*
Cadmium	213.1(2)(7)	mg/L	0.02	Drum	*	.04762	105.4	Drum	.0202	*	*
Chromium	218.1(2)(7)	mg/L	0.1	Drum	*	.19048	133.3	Drum	*	*	*
Lead	239.2(2)(7)	mg/L	0.01	Drum	*	.476	3.(8)	Drum	*	*	*
Mercury	245.1(2)(7)	mg/L	0.01	Drum	*	.1	98.5	Drum	*	*	*
Selenium	270.2(2)(7)	mg/L	0.01	Drum	*	.04762	77.9	Drum	*	*	*
Silver	272.1(2)(7)	mg/L	0.01	Drum	*	.04762	108.1	Drum	*	*	*
Aldrin	608(4)	µg/g	0.01	MW1 20-20.5'	*	.04	130	MW1 20-20.5'	*	*	*
p,p DDT	608(4)	µg/g	0.01	MW3 #3 5-6.5'	*	.05	116	MW1 20-20.5'	*	*	*
Dieldrin	608(4)	µg/g	0.01	MW1 20-20.5'	*	0.1	117	MW1 20-20.5'	*	*	*
Endrin	608(4)	µg/g	0.01	MW1 20-20.5'	*	0.1	107	MW1 20-20.5'	*	*	*
Heptachlor	608(4)	µg/g	0.01	MW1 20-20.5'	*	.04	118	MW1 20-20-.5'	*	*	*
Lindane	608(4)	µg/g	0.01	MW1 20-20.5'	*	.04	105	MW1 20-20.5'	*	*	*
2,4-D	509B(5)	µg/g	0.01	MW1 20-20.5'	*	0.5	76	MW1 20-20-.5'	*	*	*
2,4,5-T	509B(5)	µg/g	0.01	MW1 20-20.5'	*	0.5	88.1	MW1 20-20.5'	*	*	*
2,4,5-TP (Silvex)	509B(5)	µg/g	0.01	MW1 20-20.5'	*	0.5	96	MW1 20-20.5'	*	*	*

See next page for footnotes

UBTL Quality Control Report
Buckley ANGB - Soil Analyses

(1) Results not corrected for recent moisture.
(2) Methods for Chemical Analysis of Water and Wastes, EPA 600/4-79-020, revised March 1983, modified for use with soil.
(3) Test methods for evaluating Solid Waste, SW-846, 2nd ed., July 1982, modified for use on O.I. Corp. *Model 610 TOX Analyses, with soil samples.*
(4) Methods for Organic Chemical Analyses of Municipal and Industrial Wastewater, EPA 600/4-82-057, July 1982, modified for use with soil.
(5) Standard Methods for the Examination of Water and Wastewater, 16th ed. 1985, modified for use with soil samples.
(6) Test Methods for evaluating Solid Waste, SW-846, 2nd ed., July 1982.
(7) Sample has been extracted for EP Toxicity according to method No. 1310 published in EPA Publication No. SW-846.
(8) The low recovery was checked by reanalysis and confirmed. A matrix effect is suspected.

Note: The analytical technique between the Methods published in EPA-SW-846, EPA-600/4-82-057, FPA-600/4-79-020, and Standard Methods 16th ed. are the same.

* Denotes Value less than the limit of detection.

ND Denotes the sample was not ignitable.

UBTL ANALYTICAL REPORT

Buckley ANGB - Water Analyses

Parameter	Method	Units	Detection Limit	Site 1 MW-1	Site 1 MW-3	Site 1 MW-4
Cadmium	213.1 (1)	mg/L	0.01	0.02	0.02	0.01
Chromium	218.1(1)	mg/L	0.1	*	*	*
Lead	239.2(1)	mg/L	0.01	*	*	*
Nickel	249.1(1)	mg/L	0.05	0.08	0.09	0.09
Silver	272.1(1)	mg/L	0.01	0.02	0.02	0.01
Phenolics	420.2(1)	μg/L	10.	10.	30.	10.
TDS	160.2(1)	mg/L	1.	3500	2300	2500
TOC	415.1(1)	mg/L	1.	6.1	39.	6.4
TOX	9020(2)	μg/L	10.	64.	65.	63.
Aldrin	608(3)	μg/L	0.01	*	*	*
DDD	608(3)	μg/L	0.02	*	*	*
DDE	608(3)	μg/L	0.02	*	*	*
O,P-DDT	608(3)	μg/L	0.05	*	*	*
p,p-DDT	608(3)	μg/L	0.05	*	*	*
Dieldrin	608(3)	μg/L	0.01	*	*	*
Endrin	608(3)	μg/L	0.02	*	*	*
Heptachlor	608(3)	μg/L	0.01	*	*	*
Heptachlor Epoxide	608(3)	μg/L	0.01	*	*	*
Lindane	608(3)	μg/L	0.01	*	*	*
Methoxychlor	608(3)	μg/L	0.1	*	*	*
2,4-D	509B(4)	μg/L	0.05	*	*	*
2,4,5-TP	509B(4)	μg/L	0.05	*	*	*
2,4-T	509B(4)	μg/L	0.05	*	*	*

See Water Q.C. report for footnotes.

UBTL QUALITY CONTROL REPORT
Buckley ANGB - Water Analyses

Parameter	Method	Units	Detection Limit	Spiked Sample	Initial Value	Spike Conc.	Percent Recovered	Split Sample	First Value	Second Value	Method Blank
Cadmium	213.1(1)	mg/L	0.01	S-1,MW-4	0.014	.0476	96.5	S-1,MW-4	.0119	.0142	*
Chromium	218.1(1)	mg/L	0.1	S-1,MW-4	*	.2381	88.6	S-1,MW-4	*	*	*
Lead	239.2(1)	mg/L	0.01	S-1,MW-4	*	.4762	7.(5)	S-1,MW-4	*	*	*
Nickel	249.1(1)	mg/L	0.01	S-1,MW-4	.0933	.4762	75.3	S-1,MW-4	.101	.101	*
Silver	272.1(1)	mg/L	0.01	S-1,MW-4	.014	.0476	85.4	S-1,MW-4	.0162	.0138	*
Phenolics	420.2(1)	µg/L	10.	S-1,MW-4	*	99	97	S-1,MW-4	13.6	12.3	*
TDS	160.2(1)	mg/L	1					S-1,MW-4	2500	2500	*
TOC	415.1(1)	mg/L	1.	S-1,MW-4	6.4	2	130.	S-1,MW-4	6.33	6.46	*
TOX	9020(2)	µg/L	10.	S-1,MW-4	63.	18	129.	S-1,MW-4	60	66	*
Aldrin	608(3)	µg/1	0.01	S-1,MW-4	*	.20	105	S-1,MW-4	*	*	*
p,p-DDT	608(3)	µg/L	0.05	S-1,MW-4	*	.50	132	S-1,MW-4	*	*	*
Dieldrin	608(3)	µg/L	0.01	S-1,MW-4	*	.50	108	S-1,MW-4	*	*	*
Endrin	608(3)	µg/L	0.02	S-1,MW-4	*	.50	152	S-1,MW-4	*	*	*
Heptachlor	608(3)	µg/L	0.01	S-1,MW-4	*	.20	105	S-1,MW-4	*	*	*
Lindane	608(3)	µg/L	0.01	S-1,MW-4	*	.20	110	S-1,MW-4	*	*	*
2,4-D	509B(4)	µg/L	0.05	S-1,MW-4	*	2.5	94	S-1,MW-4	*	*	*
2,4,5-TP (Silvex)	509B(4)	µg/L	0.05	S-1,MW-4	*	2.5	86	S-1,MW-4	*	*	*
2,4,5-T	509B(4)	µg/L	0.05	S-1,MW-4	*	2.5	90	S-1,MW-4	*	*	*

See next page for footnotes.

UBTL QUALITY CONTROL REPORT
Buckley ANGB - Water Analyses

(1) Methods for Chemical Analysis of Water and Wastes, EPA 600/4-79-020, Revised March 1983.
(2) Test Methods for evaluating Solid Waste, SW-846, 2nd ed. July 1982, modified for use on O.I. Corp Model 610 TOX Analyses.
(3) Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater, EPA 600/4-82-057, July 1982.
(4) Standard Methods for the Examination of Water and Wastewater, 16th ed. 1985.
(5) The low recovery was checked by reanalysis and confirmed. A matrix effect is suspected.

Note: The analytical technique between the Methods published in EPA-SW-846, EPA-600/4-82-057, EPA 600/4-79-020, and Standard Methods 16th ed. are the same.

* Denotes Value less than the limit of detection.

UBTL ANALYTICAL REPORT
Buckley ANGB - Soil Analyses (1)

Parameter	Method	Units	Detection Limit	Site 1 MW4 #1 0-1.5'	Site 1 MW4 #3 5-6.5'	Site 1 MW4 #5 15-16.5'	Site 1 MW3 #1 0-1.5'	Site 1 MW3 #3 5-6.5'	Site 1 MW3 #5 15-16.5'	Site 1 MW1 20-20.5'	Site 1 MW2 43-43.5'
% Moisture	160.3(2)	%	1.	15.	8.	21.	13.	9.	22.	10.	10.
Phenolics	420.2(2)	µg/g	1.	*	*	*	*	3	*	8	5
TOC	415.1(2)	µg/g	5.	4100.	1400.	2900.	3700.	2400.	2700.	1200.	870.
TOX	9020(3)	µg/g	5.	*	*	*	*	*	*	*	*
Aldrin	608(4)	µg/g	0.01	*	*	*	*	*	*	*	*
Dieldrin	608(4)	µg/g	0.01	*	*	*	*	*	*	*	*
Endrin	608(4)	µg/g	0.01	*	*	*	*	*	*	*	*
Heptachlor	608(4)	µg/g	0.01	*	*	*	*	*	*	*	*
Heptachlor Expoxide	608(4)	µg/g	0.01	*	*	*	*	*	*	*	*
Lindane	608(4)	µg/g	0.01	*	*	*	*	*	*	*	*
Methoxychlor	608(4)	µg/g	0.01	*	*	*	*	*	*	*	*
2,4-D	509B(5)	µg/g	0.01	*	*	*	*	*	*	*	*
2,4,5-T	509B(5)	µg/g	0.01	*	*	*	*	*	*	*	*
2,4,5-TP -- (Silvex)	509B(5)	µg/g	0.01	*	*	*	*	*	*	*	*
DDD	608(4)	µg/g	0.01	*	*	*	*	*	*	*	*
DDE	608(4)	µg/g	0.01	*	*	*	*	*	*	*	*
o,p DDT	608(4)	µg/g	0.01	*	*	*	*	*	*	*	*
p,p DDT	608(4)	µg/g	0.01	*	*	*	*	*	*	*	*

See Soil Q.C. report for footnotes.

UBTL ANALYTICAL REPORT
Buckley ANGB ~ Soil Analyses (1)

Parameter	Method	Units	Detection Limit	Site 2 FT2-B1#1 0-1.5'	Site 2 FT2-B1#3 5-6.5'	Site 2 FT2-B2#1 0-1.5'	Site 2 FT2-B2#3 5-6.5'
Lead	239.1(2)	µg/g	10	47.	39.	40.	43.
% Moisture	160.3(2)	%	1.	16.	16.	15.	19.
Phenolics	420.2(2)	µg/g	1.	2.	*	3.	*
TOC	415.1(2)	µg/g	5.	5700.	1900.	4200.	1500.
TOX	9020(3)	µg/g	5.	*	*	*	*

See Soil Q.C. report for footnotes.

UBTL ANALYTICAL REPORT

Buckley ANGB - Soil Analyses (1)

Parameter	Method	Units	Detection Limit	Site 3 FT3-B1#1 0-1.5'	Site 3 FT3-B1#3 5-6.5'	Site 3 FT3-B2#1 0-1.5'	Site 3 FT3-B2#3 5-6.5'
Lead	239.1(2)	μg/g	10	20	37	45	29
% Moisture	160.3(2)	%	1.	11.	11.	9.	4.
Phenolics	420.2(2)	μg/g	1.	6.	5.	4.	3.
TOC	415.1(2)	μg/g	5.	5800.	4300.	3700.	1500.
TOX	9020(3)	μg/g	5.	8.6	*	*	*

See Soil Q.C. report for footnotes

UBTL ANALYTICAL REPORT
Buckley ANGB - Soil Analyses (1)

Parameter	Method	Units	Detection Limit	Site 4 FT1-B1#1 0-1.5'	Site 4 FT1-BL#3 5-6.5'	Site 4 FT1-B2#1 0-1.5'	Site 4 FT1-B2#3 5-6.5'
Lead	239.1(2)	μg/g	10.	34.	34.	44.	31.
% Moisture	160.3(2)	%	1.	13.	11.	6.	13.
Phenolics	420.2(2)	μg/g	1.	7.	10.	1.	*
TOC	415.1(2)	μg/g	5.	2200.	1100.	4900.	2600.
TOX	9020(3)	μg/g	5.	*	*	*	*

See Soil Q.C. report for footnotes.

UBTL ANALYTICAL REPORT
Buckley ANGB - Soil Analyses (1)

Parameter	Method	Units	Detection Limit	Site 5 5-B1 #1 0-1.5'	Site 5 5-B1 #3 5-6.5'	Site 5 5-B2 #1 0-1.5'	Site 5 5-B2 #3 5-6.5'	Site 5 B-3 #1 0-1.5'	Site 5 B-3 #3 5-6.5'
Lead	239.1(2)	µg/g	10.	38	25	77	38	34	24
% Moisture	160.3(2)	%	1.	17.	15.	19.	18.	20.	15.
Phenolics	420.2(2)	µg/g	1.	*	1.	1.	*	*	3
TOC	415.1(2)	µg/g	5.	3300.	400.	4800.	2400.	4200.	1900
TOX	9020(3)	µg/g	5.	*	*	*	*	*	*

See Soil Q.C. report for footnotes.

UBTL ANALYTICAL REPORT
Buckley ANGB - Soil Analyses (1)

Parameter	Method	Units	Detection Limit	Drum
Ignitability	1010(6)			ND
Arsenic	206.2(2)(7)	mg/L	0.01	*
Barium	208.1(2)(7)	mg/L	0.1	*
Cadmium	213.1(2)(7)	mg/L	0.02	*
Chromium	218.1(2)(7)	mg/L	0.1	*
Lead	239.2(2)(7)	mg/L	0.01	*
Mercury	245.1(2)(7)	mg/L	0.4	*
Selenium	270.2(2)(7)	mg/L	0.01	*
Silver	272.1(2)(7)	mg/L	0.01	*
Endrin	509A(5)(7)	µg/L	0.02	*
Lindane	509A(5)(7)	µg/L	0.01	*
Methoxychlor	509A(5)(7)	µg/L	0.1	*
Toxaphene	509A(5)(7)	µg/L	1.0	*
2,4-D	509B(5)(7)	µg/L	0.05	*
2,4,5-TP	509B(5)(7)	µg/L	0.05	*

See Soil Q.C. report for footnotes.

APPENDIX H

REFERENCES

REFERENCES

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Hillier, D.E., Schneider, P.A., Jr., and Hutchinson, E.C., 1983, Well Yields and Chemical Quality of Water from Water-Table Aquifers in the Greater Denver Area, Front Range Urban Corridor, Colorado. USGS Map I-856-J, scale 1:100,000.

Simons, Li & Associates, 1982, Installation Restoration Program, Phase I, Initial Assessment/Records Search, Buckley Air National Guard Base, Colorado. Contract No. DAHAO-5-82-C0006; Fort Collins, Colorado.

Robson, S.G., and Romero, J.C., 1981, Geologic Structure, Hydrology, and Water Quality of the Denver Aquifer in the Denver Basin, Colorado. USGS, Atlas HA-646, 3 sheets, scale 1:500,000.

Robson, S.G., Romero, J.C., and Zawistowski, S., 1981, Geologic Structure, Hydrology, and Water Quality of the Arapahoe Aquifer in the Denver Basin, Colorado. USGS Atlas HA-647, sheets 1 and 3, scale 1:500,000; sheet 2, scale 1:250,000.

Robson, S.G., Wacinski, A., Zawistowski, S., and Romero, J.C., 1981, Geologic Structure, Hydrology, and Water Quality of the Laramie-Fox Hills Aquifer in the Denver Basin, Colorado. USGS Map HA-650, 3 sheets, scale 1:500,000.

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_____, 1979, National Secondary Drinking Water Regulations. 40 CFR 143.

_____, 1982, Test Methods for Evaluating Solid Waste. SW-846, 2nd edition.

_____, 1983, Chemical Analysis of Water and Wastes. EPA 600/4-79-020.

APPENDIX I

BIOGRAPHIES OF KEY PERSONNEL

Curriculum Vitae

KENNETH J. STIMPFL

Title	Partner
Expertise	Environmental Analysis Impact Assessment Site and Route Selection Aquatic Ecology
Experience With Firm	Principal-in-Charge/Project Director

- Review of permits and plant operations for regulatory compliance at four chemical plants in the midwest.
- Hydrological and aquatic ecological assessment and hearing testimony in support of petition for a variance from water quality standards.
- Technical project planning, hazardous waste, field investigations, feasibility studies and clean-up strategies for U.S. Air Force facilities in Alaska, Idaho, Colorado, Nevada, Arizona and New York.
- Site selection and evaluation study for additions to existing fossil power plants, Michigan.
- Environmental assessment, permits and hearing for a new manufacturing plant in Michigan.
- Environmental baseline studies for a fossil-fueled power plant, Michigan.
- Environmental and geohydrological assessment of inactive industrial waste site, Michigan.
- Geohydrological assessment of chemically contaminated site, Michigan.
- Environmental assessment and defense in litigation for oil well development, Michigan.
- Environmental and engineering evaluation of manufacturing plant sites in Iowa, Indiana, Missouri, Michigan, Wisconsin, and Ontario.
- Ecological assessment of potential chemical contamination in the Menominee River, Wisconsin.
- Environmental assessment, preliminary containment design, and negotiation of consent judgment with state and federal agencies for a contaminated chemical plant site, Michigan.
- Site selection study for a new fossil or nuclear power plant, Michigan.
- Preparation of a regulatory compliance plan for a proposed synfuels project, Illinois.
- Radiation survey, assessment, decontamination and health physics monitoring for NRC release of contaminated plant site, Michigan.
- Wetland assessment, development of alternative layouts and agency negotiations regarding a denied 404 permit for a dock in Wisconsin.
- Assessment of environmental enhancement potential through selective dredging of the Little Calumet River for the Chicago District, Corps of Engineers.
- Assessment of potential economic impacts from a proposed regulation to ban landfill disposal of chlorinated solvents for the Illinois Department of Energy and Natural Resources.
- Assessment of aquatic impacts and effects on low-level hydroelectric potential for a variety of proposed dam modifications on the Fox River for the Chicago District, Corps of Engineers.

Project Manager

- Aquatic ecology baseline study and impact assessment for nuclear power plant in Wisconsin, Wisconsin Electric Power Company.
- Environmental baseline studies and impact assessment for copper/zinc mine in Wisconsin, Exxon Minerals Company.
- Power plant site selection study.

Past Experience

Sargent & Lundy Engineers, Chicago, Illinois

- Power plant site selection and evaluation studies in Illinois, Iowa, Wisconsin, Indiana, and studies in Illinois, Iowa, Wisconsin, Indiana, and Oklahoma.
- Ecological baseline studies and impact assessments for thirteen fossil and nuclear power plants.
- Impact assessment, route selection and evaluation of alternative designs for transmission line in West Virginia.
- Evaluation of alternate cooling systems for nuclear power plant.

Faculty Appointment, Indiana University

Assistant Professor of Zoology, Colorado State University

Academic Background

B.S., zoology, Northern Illinois University
M.S., zoology, Colorado State University
Ph.D., *limnology, Indiana University*

Professional Affiliations

Ecological Society of America; American Society of Limnology and Oceanography; National Association of Environmental Professionals; Societas Internationalis Limnologiae; Illinois Association of Environmental Professionals; Consulting Engineers Council of Illinois

Registration

Certified senior ecologist (Ecological Society of America)

Publications

Numerous technical reports, environmental assessments and environmental reports.

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Curriculum Vitae

LAWRENCE EDWARD COPE

Title	Hydrogeologist
Expertise	Ground Water Hydrology, Geology
Experience with Firm	o Participated in soil and ground water investigations on potential industrial contamination sites in Colorado, Wyoming, and Nebraska. Work included drilling supervision, ground water sampling, and aquifer testing and analysis. o Supervised drilling, well completion, and ground water sampling activities at a hazardous waste site in Colorado. o Project coordinator for industrial plant site selection study in Wyoming. Also project staff member on various environmental assessment and site selection studies in the western United States. o Field geologist sampling and logging soils for foundation engineering studies in Montana. o Field geologist on gold placer explorations projects in Wyoming and Amazon Basin, Brazil.
Past Experience	o Staff hydrologist for an earth sciences and engineering consulting company. Involved with ground water investigation for proposed in-situ uranium mine in Wyoming. Also involved with dewatering control system design for open-pit lignite mine in Mississippi. o Assistant hydrologist for U.S. Geological Survey, Water Resources Division, Nuclear Hydrology Department. Member of research team studying hydrologic suitability of proposed site as a nuclear waste repository. Work included design and implementation of downhole instrumentation package and data acquisition system, laboratory testing of system, and computer analysis and presentation of data.
Academic Background	B.A., Earth Sciences, University of Colorado, Boulder, 1978
Professional Affiliations	National Water Well Association Colorado Ground Water Association

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Curriculum Vitae

M. CAROL MC CARTNEY

Title Project Hydrogeologist

Expertise
Hydrogeology
Glacial Stratigraphy and Geomorphology
Environmental Geology
Regulatory Analysis and Liaison
Environmental Data Base Management

Experience with Firm

- Investigation of ground water contamination at U.S. Air Force bases.
- Creation of computer data base to display air pollution/emissions data.

Past Experience

Environmental Scientist, Wisconsin Power & Light Company

- Managing contracts with consulting firms in air and water quality monitoring programs.
- Interpreting technical reports on air and water quality for company management.
- Acting as company liaison to technical staff of state and federal regulatory agencies.
- Observing and participating in air and ground water quality laws and rules development in Wisconsin.
- Reviewing and interpreting environmental laws and regulations for effect on company's policy, actions, and position papers.

Hydrogeologist, Residuals Management Technology, Inc.

- Design and implementation of water quality monitoring programs at mining, industrial, and hazardous waste land disposal sites and hazardous waste treatment facilities.
- Directed studies and field investigations to determine the feasibility of initiating landfill operations at new sites, and expanding operations at existing sites.
- Conducted screening studies to find landfill sites to meet environmental regulations for industrial and mining waste.

Academic Background
B.A., Geology, University of Colorado, Boulder, 1973
M.S., Geology, University of Wisconsin, Madison, 1976
Ph.D., Geology, University of Wisconsin, Madison, 1979

Professional Affiliations
American Water Resources Association, Wisconsin Section, President-elect, 1984-85
Certified Soil Tester, State of Wisconsin
Sigma Xi

Publications Author of technical papers and maps on glacial deposits and glacial history in Wisconsin.

Curriculum Vitae

CAROL JEAN SCHOLL

Title Staff Geologist

Expertise Geology
Ground Water Hydrology

Experience with Firm

Staff Geologist, 1983-

- o Managed hazardous waste field investigation at United States Air Force (USAF) facility, Illinois. The program involved the analysis and evaluation of hazardous materials in soil and ground water including fuels, solvents, and trace metals.
- o Analyzed data, prepared reports, reviewed audits, and designed field investigations for numerous USAF hazardous waste studies.
- o Dames & Moore's Group Contact Coordinator for the Electric Power Research Institute's Seismic Risk Hazard Analysis Program, Region 2.
- o Prepared responses to questions posed by the NRC concerning faulting studies for a nuclear power plant in southern Indiana.

Assistant Geologist, 1973-1975

- o Assisted in the compilation and reduction of ground water data for PSARs for three nuclear power plant sites (NPPS).
- o Participated in detailed field structural geological studies of a NPPS in Pennsylvania.
- o Performed geological and ground water investigations of a NPPS contaminated by industrial wastes.
- o Performed engineering geological duties during rock coring and soil sampling program at a NPPS in northwestern Illinois.
- o Assisted in reduction of ground water data for a hydrologic study of a proposed coal strip mine in eastern Montana.

Past Experience

Head: Group Programs, Field Museum of Natural History, Chicago

- o Supervised professional and clerical staff members of a division of the Department of Education.
- o Participated in planning and decisions regarding departmental policies, budgets, and procedures.

Instructor of Geology, Field Museum of Natural History, Chicago

- o Instructed school groups, adult volunteers, and other adult groups in geology in the museum.
- o Trained adult volunteers to present geology tours.
- o Supervised a manned exhibit featuring a hands-on environment of natural history specimens.

Past Experience (cont'd)	Miami University, Oxford, Ohio o Graduate Teaching Fellow and Associate. o Graduate Teaching Assistant.
Academic Background	Course work toward Ph.D., with emphasis on Geochemistry and Mineralogy, Miami University, Oxford, Ohio M.S., Geology, 1970, Miami University, Oxford, Ohio B.S., Geology, 1966, Kent State University, Kent, Ohio
Citizenship	American
Countries Worked In	United States
Language Proficiency	English
Professional Affiliations	American Association for the Advancement of Science Mineralogical Society of America National Water Well Association

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Curriculum Vitae

STEVE A. WERNER

Title	Ground Water and Geotechnical Assistant
Expertise	Ground and Surface Water Hydrology
Experience with Firm	o Field Supervisor of drilling, well installation, and sampling for hazardous waste contamination investigations in Utah and Colorado. o Conducted ground and surface water sampling for Durango UMTRAP (Uranium Mill Tailings Remedial Action Program) project. o Assisted in supervision of drilling and development of ground water monitoring for Durango UMTRAP project. o Assisted in geotechnical drilling for Durango UMTRAP project. o Assisted in field soils evaluations for Durango UMTRAP project. o Conducted all radiological sampling for Durango UMTRAP project. o Conducted all meteorological data collection for Durango UMTRAP project. o Field installation of all environmental monitoring sites.
Academic Background	B.S., Genetics, University of Utah (emphasis in Radiological Sciences)

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APPENDIX J

SAFETY PLAN

DAMES & MOORE
HEALTH AND SAFETY PLAN

Project Name and Number: Phase IIb Environmental Investigation (01016-214-07)

Project Site Location: Buckley Air National Guard Base, Colorado

Field Supervisor: Richard L. Harlan

On-Site Safety Officer:

Plan Preparer: Michael W. Ander

Plan Reviewer: Kim Petschek

Preparation Date: April 30, 1984

Plan Approvals:

Project Safety Coordinator

____

Michael W. Ander (date)

Managing Principal-in-Charge

____

George W. Nicholas (date)

Field Supervisor

____

Richard L. Harlan (date)

I. PURPOSE

The purpose of this Plan is to assign responsibilities, establish personnel protection standards, specify mandatory operating procedures, and provide for contingencies that may arise while operations are being conducted at the site.

II. APPLICABILITY

The provisions of the Plan are mandatory for all on-site Dames & Moore employees and subcontractors engaged in hazardous material management activities including but not limited to initial site reconnaissance, preliminary field investigations, mobilization, project operations, and demobilization.

III. RESPONSIBILITIES

A. Field Supervisor

The FS shall direct on-site investigation and operational efforts. At the site, the FS, assisted by the on-site Safety Officer, has the primary responsibility for:

1. Assuring that appropriate personnel protective equipment is available and properly utilized by all on-site personnel.

2. Assuring that personnel are aware of the provisions of this plan, are instructed in the work practices necessary to ensure safety, and in planned procedures for dealing with emergencies.

3. Assuring that personnel are aware of the potential hazards associated with site operations (see Tables 1 and 2).

4. Monitoring the safety performance of all personnel to ensure that the required work practices are employed.

5. Correcting any work practices or conditions that may result in injury or exposure to hazardous substances.

6. Preparing any accident/incident reports (see attached Accident Report Form).

7. Assuring the completion of Plan Acceptance and Feedback forms attached herein.

B. Project Personnel

Project personnel involved in on-site investigations and operations are responsible for:

1. Taking all reasonable precautions to prevent injury to themselves and to their fellow employees.

2. Implementing Project Health and Safety Plans, and reporting to the FS for action any deviations from the anticipated conditions described in the Plan.

3. Performing only those tasks that they believe they can do safely, and immediately reporting any accidents and/or unsafe conditions to the FS.

IV. BACKGROUND

Based on preliminary site evaluations of Buckley ANGB, Colorado, there appear to be five (5) areas that may have generated significant environmental contamination over the lifetime of the facility. Suspected contaminants have been identified; quantification awaits future investigation based on sampling and analysis. Dames & Moore anticipates that site conditions are such that only relatively low levels of contaminants may be encountered during the proposed drilling and soil and water sampling.

Base Dump and Oil Pit — The base dump was in use from 1942 through 1982. Materials disposed of include municipal refuse, building materials, paint cans, pesticide containers, fuel tank sludges, solvent containers, scrap metal, and asbestos brake pads. The oil pit received waste oil products from 1950 through 1982, and the contents of the pit were occasionally burned in the 1950s. The Phase I report notes that the pit currently contains standing oil and possibly waste solvents.

Fire Training Areas — FTA No. 2 was operated from the early 1950s until 1972, during which time approximately 150 gallons of water-contaminated JP-4 fuel or AVGAS were used per training session. FTA No. 3 began operation in 1972, and similar quantities of JP-4 fuel were burned at this site. At both FTA No. 2 and No. 3, 50 to 70 percent of the fuel was burned during the exercise, the remainder being allowed to remain on site. At FTA No. 1, in operation during the late 1940s and early 1950s, AVGAS was burned. It is believed that in the past, other flammable materials from the waste oil holding tank, including motor oil and solvents, were burned at these sites.

Storm Drainage System (near Building 801) — This area was used for washing and painting aircraft between 1942 and 1982. Materials washed off the apron include fuels, cleaning compounds, ethylene glycol, paints, and strippers.

A. Dames & Moore Activity

Dames & Moore will drill soil borings at the fire training areas and the storm drainage system area and collect soil samples. Monitoring wells will be installed south and north of the base dump and oil pit. Soil samples will be collected from the monitoring well borings.

B. Suspected Hazards

Suspected hazards are present in as much detail as is currently available. These are POL (waste petroleum, oils, and solvents) products, JP-4 fuel, AVGAS, pesticides, and paint.

V. EMERGENCY CONTACTS AND PROCEDURES

Should any situation or unplanned occurrence require outside or support services, the appropriate contact from the following list should be made:

Agency	Person to Contact		Telephone
D&M Field Supervisor	R. Harlan	(office)	303-232-6262
		(home)	303-988-2366
D&M Industrial Hygiene and Safety Director	K. Petschek	(office)	914-761-6323
		(home)	212-724-6414
Police			
Fire			
Ambulance			
Hospital			
Command Post			

In the event that an emergency develops on site, the procedures delineated herein are to be immediately followed. Emergency conditions are considered to exist if:

- o Any member of the field crew is involved in an accident or experiences any adverse effects or symptoms of exposure while on scene.
- o A condition is discovered that suggests the existence of a situation more hazardous than anticipated.

The following emergency procedures should be followed:

a. In the event that any member of the field crew experiences any adverse effects or symptoms of exposure while on scene, the entire field crew should immediately halt work and act according to the instructions provided by the Field Supervisor.

b. The discovery of any condition that would suggest the existence of a situation more hazardous than anticipated should result in the evacuation of the field team and reevaluation of the hazard and the level of protection required.

c. In the event that an accident occurs, the FS is to complete an Accident Report Form for submittal to the MPIC of the office, with a copy to the Health and Safety Program Office. The MPIC should assure that followup action is taken to correct the situation that caused the accident.

VI. MONITORING METHODS AND PROTECTION REQUIRED

Monitoring Methods, Action Levels and Protective Measures

Methods for monitoring for suspected contaminants, action levels, and protective measures to be used for various contaminant concentration levels are presented in Table 1.

Protective Equipment Required for On-Site Activities

The protective equipment required may vary, depending on the concentrations and dispersion of contaminants encountered during each phase of the work. Table 2 specifies protective equipment required for each on-site activity.

FORM #IHST-1

REVIEW RECEIPT

PROJECT HEALTH AND SAFETY PLAN

Instructions: This form is to be completed by each person to work on the site and returned to the Program Director-Industrial Hygiene and Safety.

Job No. 01016-214-07

Project: Buckley Air National Guard Base, Colorado

Rev. No. 0 Date 04/30/84

I represent that I have read and understana the contents of the above plan and agree to perform my work in accordance with it.

____
Signed

____
Date

TABLE 1

HAZARD MONITORING METHOD, ACTION LEVELS, AND PROTECTIVE MEASURES

Hazard	Monitoring Method	Action Level	Protective Measures
Toxic atmosphere	HNU continuous recorder	>5 units	Don respirator. See Table 1 for exposure standards.

TABLE 2

PROTECTIVE EQUIPMENT

Level	Protective Equipment	Criteria for Use
C	Full-face respirator with air-purifying cartridges for gas/dusts	When drilling or sampling where dusts become airborne, when organic odors are noticeable, or as indi cated by HNU.
	Disposable coveralls	
	Rubber boots	
	Hard hat with splash shield or safety glasses/goggles	
	Nitrile gloves	
D	Rubber boots	During sampling activities other than those mentioned above
	Disposable coveralls (optional)	
	Nitrile gloves	
	Safety glasses or goggles	
	Hard hat	

END
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